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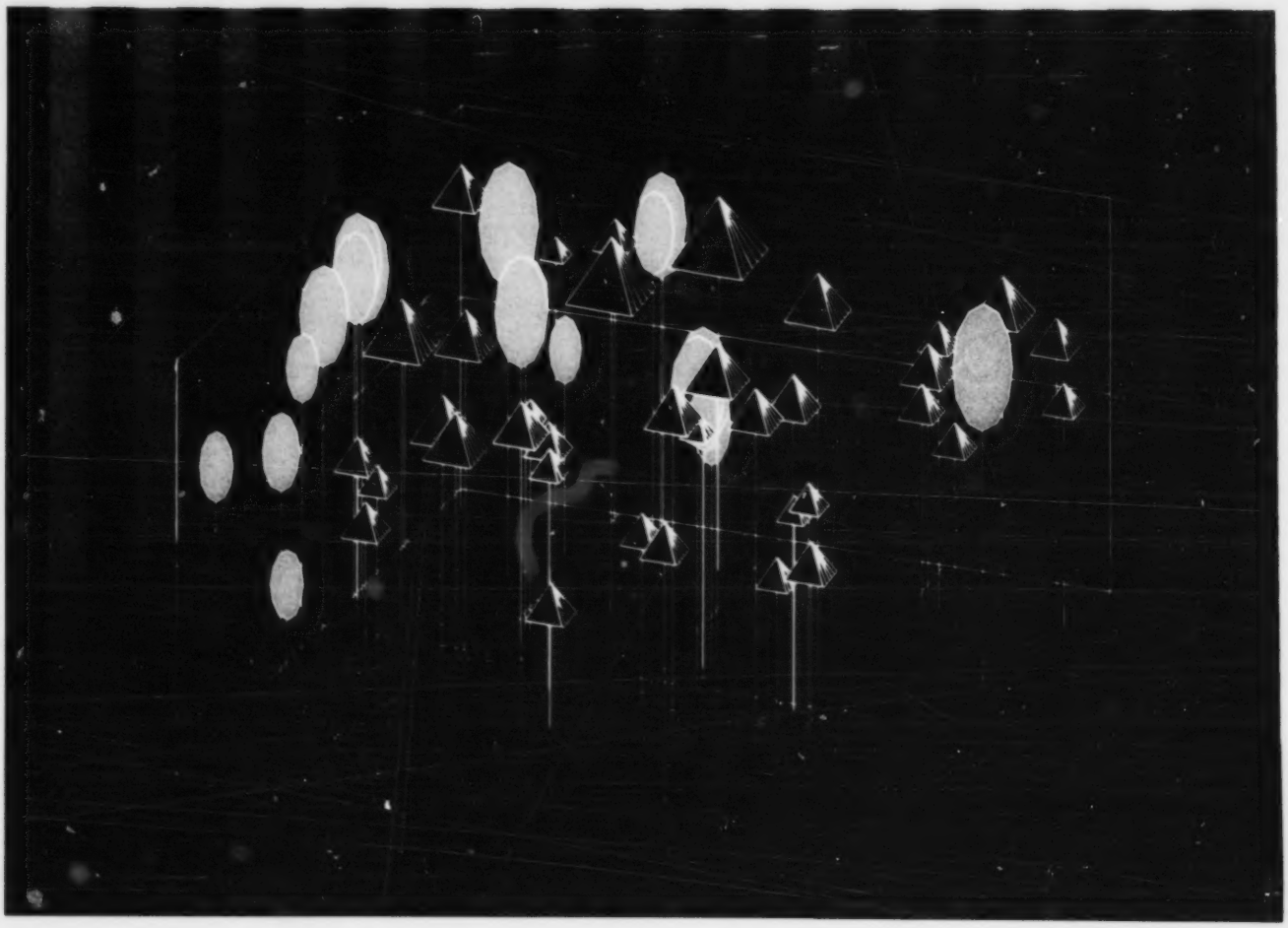
ACID RAIN NATIONAL EARLY WARNING SYSTEM

Manual on Plot Establishment and Monitoring

L.P. Magasi

Information Report DPC-X-25
Forest Science Directorate



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- Administers forest development agreements negotiated with the provinces
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- Promotes employment, education, and training opportunities in the forest sector.
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- il favorise les occasions d'emploi et de formation universitaire et technique dans le secteur forestier
- il encourage les Canadiens à prendre conscience de tous les aspects du secteur forestier.

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Manual on Plot Establishment and Monitoring

L.P. Magasi

Canadian Foresty Service — Maritimes
Forest Insect and Disease Survey
Fredericton, New Brunswick

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The preparation of this manual was guided by a set of basic rules provided by the original development committee. The system was developed based on advice from many people of wide-ranging expertise, both within the Forest Insect and Disease Survey (FIDS) and the Long Range Transportation of Air Pollutants (LRTAP) group of the Canadian Forestry Service. To all goes credit for their contribution. Special thanks go to Dr. M.K. Mahendrappa, the original chairman of the Soil Monitoring Subcommittee, and to Dr. I.K. Morrison who finalized the soil and foliage sampling and analysis protocol.

The major credit, however, is due to the people in my own FIDS unit in the Maritimes, particularly to the two senior FIDS technicians, Mr. W. Ray Newell and especially Mr. Fred A. Titus who tested, modified, and retested all the procedures until "we got it right." I am also grateful to Fred for his invaluable assistance in the preparation of the final version and to Anita Jones who retyped the manuscript so often.

INTRODUCTION

Acid rain has been a global concern for the past few years and the effects of impurities in the air on lakes, buildings, and the forest are becoming more apparent in many parts of the world.

"Acid rain" means more than just rain with lower than normal pH. It has become the popular generic term encompassing all forms of air pollution — wet precipitation, dry deposition, ambient gaseous concentrations of pollutants, and airborne particulates including heavy metals. These pollutants, alone or in combination, may directly or indirectly affect the health of Canada's forest — their normal development, the production of wood, or the forests' role in providing a healthy environment.

Concern over the future of Canadian forests has intensified as a result of the alarming tree mortality observed in other parts of the world. The Acid Rain National Early Warning System (ARNEWS) came into being in early 1984 when the Canadian Forestry Service decided to establish a national program to detect, clearly and accurately, early signs of acid rain damage to Canada's forests before damage becomes obvious.

The objectives of the program are:

1) to detect the possible damage to forest trees and soils caused by acid rain or to identify the damage sustained by Canadian forests (trees and soils) that are not attributable to natural causes or management practices;
2) long-term monitoring of vegetation and soils to detect future changes attributable to acid deposition and other air pollutants in representative forest ecosystems.

The Forest Insect and Disease Survey was given responsibility for (1) plot establishment, (2) above-ground parameter monitoring and sampling, and (3) assisting in obtaining foliage and soil samples for chemical analysis.

Permanent plots are to be maintained in all regions of Canada to monitor:

1) the condition and changes in the condition of the forest stand;
2) the presence and fluctuation of biotic and abiotic factors that affect the condition of the forest (insects, diseases, stand changes, temperature, etc.);
3) the changes and symptoms that indicate factors not attributable to (2) that could be early signs of acid rain damage; and
4) the effect of acid rain on the condition of the various economically important tree species.

Without close monitoring of all the factors mentioned, the expected, initially subtle, effects of acid rain cannot be isolated and identified. In particular, attention was directed to symptoms reported to be typical of acid rain damage in West Germany, namely casting of green or uncharacteristically shaped needles, premature discoloration and shedding of needles, unexplained dieback, early flattening of tree crowns ("storks nesting"), abrupt decline in foliage or annual ring growth, etc.

This manual describes the Acid Rain National Early Warning System (ARNEWS) of the Canadian Forestry Service, and provides a set of guidelines for the establishment of the network of plots and for the uniform monitoring of the parameters selected by a committee in 1984. The system was developed — and used — in 1984, modified somewhat in 1985, and finalized, again with minor modifications, in 1986.

This document is an instruction manual describing the details of the work to be done on the plots, and the when, what, and how. Discussion on the reasons for doing the various assessments is minimal. The manual is divided into two distinct parts. Part I describes ARNEWS and Part II describes the ARNEWS procedures to be carried out.

PART I. DESCRIPTION OF ARNEWS

ABOVE-GROUND PARAMETERS FOR ARNEWS PLOTS

The Development Committee decided on several above-ground parameters to be monitored on the ARNEWS plots. Parameters chosen are a combination of the optimum, minimum, desirable, and practical. Not all parameters are monitored with the same frequency and not all parameters can be evaluated by a single annual visit. For each ARNEWS plot there is to be a base year during which all parameters are assessed and the information is to serve as baseline data.

The assessment of some parameters requires destructive sampling, such as removing tree branches and taking increment cores or foliage samples. No plot tree should be subjected to any treatment that in any way affects its natural condition or influences changes induced by external factors. Therefore all sampling must be done on off-plot trees of the appropriate species to represent those on the plot. This may result in a certain amount of interpolation and inference but eliminates the introduction of artifacts that would preclude proper conclusions.

A. Base year plus every 5-yr assessments

1. Radial growth
2. Vertical growth
3. Crown structure and density — partial (see B.2.)
4. Foliage sampling for analysis
5. Soil sampling for analysis

B. Base year plus annual assessments

1. Tree mortality in the stand
2. Tree condition (see also A.3)
3. Acid rain symptoms — partial (see C.1)

C. Base year plus several assessments per growing season

1. Acid rain symptoms — partial (see B.3.)
2. Insect and disease conditions
3. Seed production — optional

The Forest Insect and Disease Survey is the CFS unit responsible for monitoring these factors and carrying out the assessments. The only exception is foliage sampling for which the methodology is provided by LRTAP personnel. These samples are to be collected by FIDS and submitted for analysis. The responsibility for that work rests with other groups at CFS establishments but the results are to be provided to the ARNEWS program. FIDS personnel also assist with soil sampling, to a degree agreed on at the establishment level.

MONITORING THE PARAMETERS

The procedures represented in Part II were accepted by all FIDS units in CFS as recommended guidelines for monitoring the selected parameters. The need for uniformity must be emphasized because without comparability of information the national scope of the program will be jeopardized.

Because no destructive sampling of plot trees is allowed, additional data gathering on outside trees is necessary to collect data that can be obtained only through sampling (such as increment cores, needle retention, etc.).

Frequency of Assessments

The assessments are to be carried out with varying frequency as indicated in the following table. In the base year, the plot is established and all annual and 5-yr measurements are taken. All assessments are considered mandatory as stated and are treated as such in this manual. However, at the discretion of the CFS regional establishments some of the annual procedures requiring sampling may be made optional. If the option is exercised those procedures become 5-yr assessments.

ARNEWS plot assessments. Number(s) in parentheses indicates ARNEWS form number to be used.

5-yr	Annual
On-plot	**On-plot**
Plot tree data (3)	Plot tree assessment (4)
(Plus all of annual)	Regeneration survey (5)
	Ground vegetation survey (6)
Off-plot	**Off-plot**
Soil samples (11A)	Conifers
Foliage samples (11B)	tree assessment (7, 13)
conifer	pest assessment (8, 13)
hardwoods	Hardwoods
Increment cores (12,13)	tree assessment (9, 13)
(Plus all of annual)	pest assessment (10, 13)

Some parameters, notably forest pest conditions through a given season, should be assessed more than once if possible. Several visits are also required for reliable assessment of some of the other parameters, such as seed crop assessment for the various hardwood species maturing at different times, ground vegetation survey to account for seasonal variation of flowering, and timing of the general fall coloration.

ARNEWS Plot Work Schedule

A suggested ideal work schedule for ARNEWS plots follows:

ARNEWS plot work schedule.

Month	Procedure	ARNEWS form	Frequency
June	Pest conditions	8 and 9	annual
	Ground vegetation	6	annual
	Hardwood seed crop	4 (col. 56)	annual
July	Pest conditions	8 and 9	annual
	Ground vegetation	6	annual
	Hardwood seed crop	4 (col. 56)	annual
August	Plot tree assessment	4	annual
	Regeneration survey	5	annual
	Ground vegetation	6	annual
	Conifer-tree assessment	7, 13	annual
	Conifer-pest assessment	8, 13	annual
	Hardwood-tree assessment	9, 13	annual
	Hardwood-pest assessment	10, 13	annual
	Hardwood-foliage sample	11B, 13	5-yr
September	Pest conditions	8 and 9	annual
	Conifer-foliage sample	11B, 13	5-yr
	Soil sample	11A	5-yr
	Increment cores	12, 13	5-yr
Anytime	Plot establishment	1	base year
	Plot mapping	2	base year
	Plot tree data	3	5-yr

Insect and Disease Conditions

Without a thorough assessment of forest pests, their populations, fluctuation, damage, and other effects on the trees, the analysis of most other parameters included will be difficult. The seasonality of forest pests requires detailed work. Plot trees are assessed in general terms, off-plot trees are used for detail.

All forest pest assessment methods selected were chosen from techniques used routinely by at least some FIDS units in Canada and thus should pose no problem to FIDS personnel with acknowledged expertise in forest insect and disease surveys. The number of observations chosen satisfies the "optimum-minimum-desirable-practical" principle and they were selected on the minimum-practical end of the scale.

The regular assessment of pest conditions is a routine FIDS activity and will often coincide with other ARNEWS-related work. It is unnecessary to assess all conditions every time the plot is visited. If a pest such as needle rust was assessed at its peak period, it is unnecessary to assess the few remaining needles at the next visit. These counts would not only be unnecessary, they could actually create misleading data.

Forest pests probably influence the condition of trees more than any other factor, but there is another reason why they should be carefully studied as part of the ARNEWS program. Acid rain is unlikely to cause sudden calamities resulting in large-scale destruction of the forest. The changes are likely to be subtle and initially probably not visible. However, some of the changes may result in changes from "normal" forest pest patterns, well known for many organisms in FIDS units. The destruction of the waxy layer of tree foliage may make infection by fungi easier, changes in acidity may favor fungal growth, interference may make foliage more palatable to insects. Changes may also inhibit certain pest activities, and there are reports in the literature that this is happening. Without close attention to forest pests the ARNEWS program could be missing some important indications.

The fact that the inclusion of forest pests in the ARNEWS program will benefit other aspects of FIDS work is well recognized but is considered only as "gravy," the same way other parameters increase knowledge of forest ecology generally. Forest pests assessments are included because they are an important factor in meeting the objectives of the ARNEWS program.

Miscellaneous Other Assessments

Several parameters are needed in and around the plots that do not lend themselves to tabulation.

Aerial Photography

Aerial photography of all ARNEWS plots is necessary regularly to observe and record the conditions of the stand. Photographs should allow for the detection of changes in the upper crowns not easily seen from the ground. Photography is to be done in conjunction with other flying when practical. Regular camera lens and Kodachrome 64 film for color slides should be used at a flying altitude of about 500 m if possible. Photographs are to be taken with the aircraft between the sun and the plot, that is, the sun behind the aircraft. When opportunity allows, additional photography from low level helicopter flights using a telephoto lens and different types of films including infrared should be taken.

All photographs from ARNEWS plots must be properly labelled (include plot number, date) and submitted to the FIDS unit headquarters where they are filed along with other ARNEWS plot records.

Ground Photography

Photo plots should be established on all ARNEWS plots and photographs taken at regular intervals of the general view of the plot and of other specifically selected features to obtain a photographic record of changes (or the lack of) over time.

All photographs from ARNEWS plots must be properly labelled (include plot number, date) and submitted to the FIDS unit headquarters where they are filed along with other ARNEWS plot records.

Appearance of "Unusual" Symptoms

Unexplained or unusual symptoms may appear at different times of the season that may be masked by other conditions later (an example is the very early leaf browning of white birch along the Bay of Fundy coast). Special attention must be paid to these during the monthly visits.

Fall Coloration of Hardwoods

The date of "general" autumn coloration is to be noted in the area of the plots. In addition to observations during the monthly visits, staff will be alert to this and include it in their reports. The same applies to shrubs that may be indicator species.

COMPUTERIZING ARNEWS INFORMATION

The large amount of data will be handled with the aid of computers. Regional flexibility in data collecting notwithstanding, this requires standardization to allow uniform coding for computer input and subsequent manipulation. The wide variety of information to be obtained requires numerous forms and it is most important that the headings properly identify both the plot and the specific information group. The system will be used by both the above-ground and the below-ground monitoring groups to achieve uniformity. However, once a plot is established and all the "heading" information is available in the records, repeating all of it on all the forms is both unnecessary and time wasting. Consequently, only the necessary items from the following list were used in designing the various ARNEWS forms.

Computer handling of the ARNEWS information is the responsibility of the FIDS group at the Petawawa National Forestry Institute. Initially, copies of all completed ARNEWS forms must be submitted annually to PNFI. It is planned that some inputting will be done by the local FIDS units at a later stage and, further, that after the adoption of a system for computerized field data collecting, changes in these procedures will be implemented. However, the data will remain the same.

All columns on the ARNEWS forms are numbered and each piece of information in this manual is referred to by its code number for ease of handling the instructions and the computer input. The description of format (codes) follows.

Description of format (codes).

Column	Item	Explanation/Comments
1	Region	The single-digit FIDS region designation, e.g. Quebec = 3.
2-3	Plot number	The two-digit number denoting the plot within the region, e.g. plot 7=07, plot 15=15. In the text and on the ARNEWS forms, "plot number" implies the proper national plot designation which includes both the region number and the actual number assigned to the plot within the region, hence a three-digit number.
4-5	Subplot	The two-digit number denoting subplots within or around the plot. 00 should be entered when information relates to the entire plot, 01-20 should be reserved for ground vegetation and regeneration subplots. For the sake of coding, off-plot trees on which detailed assessment is done (increment core, sampling, etc.) may be considered subplots, but in that case a list of those must be kept in the region and also provided to the central computer group. (Use ARNEWS form 13 for off-plot trees.)
6	Blank	
7-15	UTM grid	The location of ARNEWS plots is determined to the nearest square kilometre and the nine-digit designation is entered, e.g. Upper Musquodoboit, N.S. = 205044997.
16	Blank	
17-18	Year of establishment	The two-digit number denoting the year during which the plot was established, e.g. 1984=84.
19-22	Blank	In some establishments the below-ground monitoring group uses col. 20-21 and enters 99 for all ARNEWS-related data locally.
23-28	Assessment date	Two-digit numbers for year-month-day, in that order, e.g. 15 Sept. 1985=850915. Assessment date must be logical, e.g. for increment cores or soil samples it would be the sampling date rather than the actual date of carrying out measurements or analysis.
29	Blank	
30-31	Assessment type	The two-digit number refers to the type of assessment to which the rest of the information refers. The ARNEWS form number is already entered here, e.g. ARNEWS form 3, Plot Tree Data for 5-yr assessment = 03. If new forms are developed these must be agreed to by all FIDS units, PNFI, and H.Q., before they are officially added to the system.
32	Blank	
33-79	Specific data information	The body of the information from specific forms is coded here. The columns will vary depending on the form number (assessment type).
80	Line of data record	Used only in some CFS establishments by the below-ground monitoring group and is reserved for indicating overflow from col. 33–39 if the information on the specific form requires more space. In that case 1 is entered in col. 80 and col. 81–159 are entered on line 2.

PLOT SELECTION GUIDELINES

The plots are established, dedicated to the ARNEWS program, and monitored uniformly regardless of their location in Canada to allow for interregional comparisons. Uniformity of data collection is an important consideration. However, it may be impossible to obtain some of the measurements in the specified manner under certain situations. Difficulties in some cases do not reduce the importance of the parameter. Try to maintain uniformity but use common sense to avoid collecting unreliable data.

Location of ARNEWS Plots

Plots are to be established in the region to allow for maximum representation of acid deposition regimes (where applicable) and of economically and commercially important tree species.

The recommendation of equal distribution of plots in the different deposition zones may at times contradict the recommendation regarding the equal distribution of plots in stands of economically important tree species (for example, the small area of high deposition zone in southeastern Quebec will not likely contain the same tree species in the same proportions as does the vast area of lower deposition farther north.) Obviously there should be ARNEWS plots in the different deposition zones, just as it is obvious that different tree species should be represented, or that the differences in soil sensitivity to acid rain induced changes should be considered. The distribution of the plots is left to the discretion of the regional establishments who can best judge their own situation.

To allow for consideration of climatic and other abiotic fluctuations in the evaluation process, it is important to have as much relevant information as possible. ARNEWS plots should be established near weather or acid rain monitoring stations operated by various federal, provincial, and institutional organizations, wherever practical in view of other considerations.

If possible, other "monitoring" stations such as provincial inventory plots, mensuration and other research plots should be considered since data from these will help to build background information. However, because ARNEWS plots are dedicated to this program with their special data requirements, they should be adjacent to these stations rather than sharing the already existing plots unless the original objectives of those are no longer under investigation.

ARNEWS plots are being established for 20–25-yr duration, thus plot security is important. Crown land is preferable but if private land is chosen an agreement in writing should be secured to ensure that the future of the plot is secure. ARNEWS plots should have a buffer zone, with the borders prominently marked and the plots registered in the provincial system of reserve areas.

Stand Age and Species Composition of ARNEWS Plots

Semimature stands of suitable species composition should be selected because of the long-term nature of the project. These trees are old enough to have been exposed to whatever conditions exist and should remain in existence for the planned 20–25-yr period, during which they can react to possible environmental changes. The species composition of the plots is an important consideration. Pure stands of the economically most important tree species in each region were originally recommended. However, this suggestion poses several problems:

1. Pure stands of the most important tree species do not exist in some regions.
2. The relatively small number of plots per region allows for few replications, thus comparability.
3. Semimature trees in some regions are of a size that does not allow for practical (therefore affordable) assessment.
4. The economically more important tree species may be the least sensitive to provide "early warning."
5. Tree species vary in economic importance in various regions.

Regional establishments are in the best position to determine the most suitable species composition of their ARNEWS plots within the general guidelines. It may be more useful to have a few trees of a given economically important species present on several widely spread, mixed plots than to have a single, pure plot of that species in the region with no opportunity to compare changes in condition elsewhere. If regional circumstances allow, a few widely and wisely placed pure plots will serve the same purpose.

Regional flexibility allows selecting the species and at the same time selecting areas where more sensitive, therefore better, indicator species are also included.

The only constraint imposed is that there should be at least one ARNEWS plot in each region with a white spruce (*Picea glauca*) component. This species was selected because it has a Canada-wide distribution, is economically important in all regions, and is considered among the more sensitive tree species and thus can provide the necessary linkage for the ARNEWS program.

Size of ARNEWS Plots

ARNEWS plots are 0.05 ha, 10 m x 40 m, and placed so that the longer side is as close as practical to a contour line in the stand.

PART II. ARNEWS PROCEDURES

This is a set of instructions to be used by FIDS and the LRTAP group of CFS. The instructions constitute that part of the ARNEWS program that deals with field and laboratory procedures. These also render obsolete procedures and forms contained in earlier versions of the same program (May 1984, September 1984, and May 1985), although most of the text is intact.

Procedures are in order of ARNEWS form number (except for plot establishment), regardless of the frequency with which they are to be carried out in future years (annual or 5-yr), of the location where they are to be performed (on-plot or off-plot), or of their perceived importance (mandatory or optional).

Notable exceptions to the "everything must be done in the base year" rule are the soil sampling, which may be staggered by some of the plots being done each year; the foliage sampling, because it is tied in with soil sampling; and the increment core sampling in some CFS regions.

Zero (0) has a specific meaning in many of the categories presented in this section (for example, negative, not present, 0%, normal, etc.), therefore **must not be used** on the form **to signify "no data available" or "does not apply."** To indicate that the parameter has been considered but neither of the latter two categories applies, the observer is to put a dash (—) in the appropriate box.

The format in these instructions is as follows:

- Each ARNEWS form constitutes a self-contained unit.
- Within each unit the pages are numbered in the lower corner with the section designation/page number within the unit, for example, the section dealing with the ground vegetation survey and ARNEWS form 6 is paginated 6/1, 6/2 ....
- The first page in each section deals with general rules, comments, instructions.
- The second page contains the appropriate ARNEWS form.
- Page 3 and subsequent pages contain details regarding the appropriate assessment.

The annotated list of the various sections relating to ARNEWS forms or procedures follows:

P	Plot Establishment	P	-	once in a lifetime procedure
1	Basic Plot Information	1	-	once in a lifetime procedure
2	Particulars for Plot Map	2	-	once in a lifetime procedure; there are alternative ways to do this; also includes subplot marking
3	Plot Tree Data	3	-	every 5 yr
4	Plot Tree Assessment	4	-	annual
5	Regeneration Survey	5	-	annual
6	Ground Vegetation Survey	6	-	annual; requires several assessments throughout the season
7	Detailed Tree Data for Conifers	7	-	annual, off-plot assessment
8	Detailed Pest Assessment on Conifers	8	-	annual, off-plot assessment on the same branch as for ARNEWS 7
9	Detailed Tree Data for Hardwoods	9	-	annual, off-plot assessment
10	Detailed Pest Assessment on Hardwoods	10	-	annual, off-plot assessment on the same branch as for ARNEWS 9; branch can serve for foliage sample in appropriate years.
11A	Soil Description,Sampling, and Analysis	11A	-	soil scientists are responsible for the sampling; FIDS is providing technical assistance; both field and lab. rules included
11B	Foliage Sampling and Analysis	11B	-	sampling is FIDS responsibility, analysis is LRTAP/soils; a staggered procedure on some of the plots annually; both field and lab. rules included
12	Increment Cores and Growth Ring Analysis	12	-	these should be obtained in base-year and at 5-yr intervals thereafter; includes field rules only; growth ring analysis methods (for ARNEWS form 12) are not discussed
13	Off-Plot Tree Data	13	-	for recording particulars of off-plot trees used to obtain various samples

In addition to all of this, ARNEWS plots should be visited by FIDS staff whenever possible and appropriate observations made.

PLOT ESTABLISHMENT

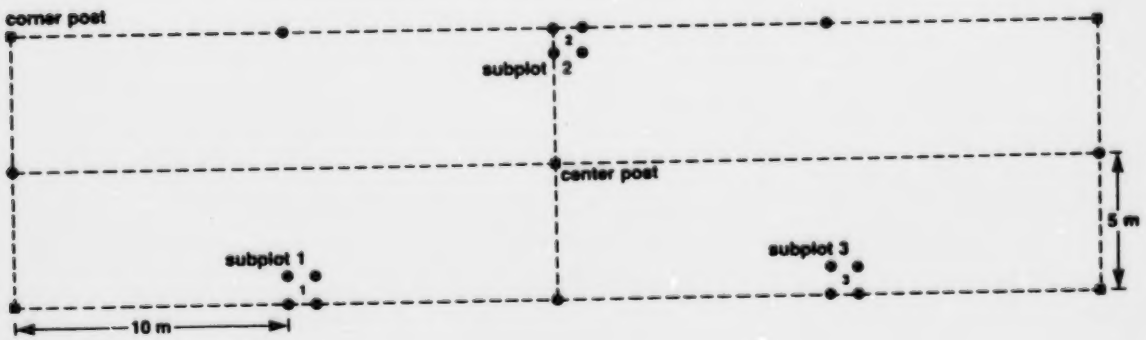
The establishment of a plot involves the physical setting up of the plot plus the gathering of baseline data. Generally accepted procedures are to be followed, only slightly modified for special requirements:

Plot Numbering System: Plots are numbered consecutively in each CFS region by two-digit numbers, preceded by the single-digit region designation, for example, plot number 5 in Quebec is designated as 3-05. This system will allow for 99 ARNEWS plots per region.

Size of the ARNEWS Plot: ARNEWS plots will be 0.05 ha, 10 m x 40 m, and placed so that the longer side will be as close as practical to a contour line in the stand.

Plot Marking:

1. Only wooden stakes should be used to mark specific reference points on plots. The use of metal stakes (especially aluminum) is strongly discouraged since some metals are implicated in connection with acid rain induced changes in soils.
2. Corner posts should be positioned first then the plot subdivided according to the illustration below. Care must be taken especially at 1, 2, and 3 to avoid trampling, as these 1 m x 1 m subplots will serve as regeneration and ground vegetation assessment areas. It is advisable to stake out the subplots early.
3. The borders of the buffer zone should be marked prominently, as agreed to by the agency under whose jurisdiction the area is, preferably as a cooperative undertaking. (The plot area should be registered with the appropriate authorities to ensure plot security.)
4. Marker posts are susceptible to damage (bears, people, rot) and are to be replaced as necessary.



Tree Numbering:

1. Tree numbers consist of four digits.
2. Trees are to be marked permanently. Metal nails should not be used in attaching tags as metals may be translocated in the tree. If numbers are painted on, the choice of paint used should be considered as many of them contain the same elements (e.g. Pb) for which soil samples will be analyzed. The use of 18- or 24-gauge plastic-coated wire to attach the tags loosely to the tree is recommended. Periodical readjustment will be necessary, as often as renewing painted numbers is necessary.
   An alternative tree numbering method involves the use of silicon material such as white bathtub sealers sold in tubes. The marking material is squeezed out of the tube to write the numbers, about 10 cm high facing the direction of usual travel on the plot. The bark of some tree species may have to be smoothed to ensure the silicon material adheres to it. Care must be taken not to injure the tree. Those numbers should be renewed occasionally.
3. All standing trees, living and dead, 10 cm or larger in diameter at breast height are numbered. Exceptions are those understory dead trees whose top does not reach into the canopy.

Adding Trees to Plot: Trees reaching the minimum 10-cm diameter for inclusion after the plot is established will be added as plot trees at 5-yr intervals. These are to be numbered, mapped, then treated as all other plot trees. (FIDS units are to notify PNFI of the changes in the total number of plot trees as this will affect calculations.)

BASIC PLOT INFORMATION

ARNEWS Form 1

This form must be completed only once for the life of a given plot.

The information, recorded when plot establishment is completed, gives some of the most basic characteristics of the plot. It also eliminates the need to repeat basic information during the years on the various forms, a time-consuming aspect of repetitious form filling (such as the nine-digit UTM grid designation).

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BASIC PLOT INFORMATION
ACID RAIN - NATIONAL EARLY WARNING SYSTEM

INFORMATION DE BASE SUR LA PARCELLE
DISPOSITIF NATIONAL D'ALERTE RAPIDE DES PLUIES ACIDES

ARNEWS DNARPA 1

Assessment Type / Type d'évaluation [ ][ ] (1 2)

Plot Number / Numéro de la parcelle [ ][ ][ ] (3 4 5)

UTM Grid / Coordonnées selon le quadrillage MTU [ ][ ] (6 7) [ ][ ] (8 9) ([ ] 10) [ ][ ][ ] (11 12 13) ([ ] 14)

Location /Localisation

_____

_____

_____

_____

_____

Plot Orientation / Orientation de la parcelle [ ][ ][ ] (15 16 17) °

Year of Establishment / Année d'établissement de la parcelle [ ][ ] (18 19)

Date of Mapping / Date de mise en plan [ ][ ][ ][ ][ ][ ] (20 21 22 23 24 25)

Elevation / Élévation [ ][ ][ ][ ] (28 29 30 31) m

Comments /Remarques

AGR 3346 (87-04)

Canada

BASIC PLOT INFORMATION

ARNEWS Form 1

Assessment type: (Col. 1-2)	The two-digit number refers to the type of assessment to which the rest of the information refers. In most cases the ARNEWS form number is to be entered here, e.g. ARNEWS form 3, Plot Tree Data for 5-yr assessment = 03.
Region: (Col. 3)	The single-digit FIDS region designation, e.g. Quebec = 3.
Plot number: (Col. 4-5)	The two-digit number denoting the plot within the region, e.g. plot 7 = 07, plot 15 = 15.
UTM grid: (Col. 6-14)	The location of ARNEWS plots is determined to the nearest square kilometre and the nine-digit designation is entered, e.g. Upper Musquodoboit, N.S. = 205044997.
Location:	Describe in as much detail as necessary. Give appropriate information such as name of the plot, nearest town, county, township, municipality, province, etc.
Plot orientation: (Col. 15-17)	Compass bearing from magnetic north. Three-digit number to express orientation of the longer center line of the plot from N in a clockwise direction.
Year of establishment: (Col. 18-19)	The two-digit number denoting the year during which the plot was established, e.g. 1985 = 85.
Date of mapping: (Col. 20-25)	Two-digit numbers for year-month-day, in that order, e.g. 15 September 1985 = 850915.
Elevation: (Col. 28-31)	Four-digit number for elevation from sea level (in metres) to be recorded, e.g. 800 m = 0800.
Comments:	Use as appropriate. This "box" is an ideal place to give precise directions on how to find the plot in the field.

PARTICULARS FOR PLOT MAP

ARNEWS Form 2

Mapping of trees is to follow tree numbering. The form is to be filled out in the base year. At 5-yr intervals when new trees are added because of in-growth, they must be mapped.

Two alternative ways of mapping plot trees are presented here, the bearing method and the coordinates method. Either is acceptable.

Initial subplot mapping should be done simultaneously.

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PARTICULARS FOR PLOT MAP / MISE EN PLAN DE LA PARCELLE

ACID RAIN - NATIONAL EARLY WARNING SYSTEM / DISPOSITIF NATIONAL D'ALERTE RAPIDE DES PLUIES ACIDES

ARNEWS DNARPA 2

Assessment Type / Type d'évaluation: 0 2 (1 2)

Plot No. / Nº de la parcelle: (3 4 5)

Date Mapped / Date de mise en plan: (20 21 22 23 24 25)

Location /Localisation

Mapped By / Mise en plan par

Page of / de

Tree Number / Numéro de l'arbre				Bearing from Center Post / Azimut à partir du piquet central		Distance along Center Line (m) / Distance le long de la ligne de centre			Bearing from Center Line / Azimut à partir de la ligne de centre		Distance from Center Line (m) / Distance à partir de la ligne de centre			Remarks / Remarques
33	34	35	36		:	37	38	39		:	40	41	42	

PARTICULARS FOR PLOT MAP

ARNEWS Form 2

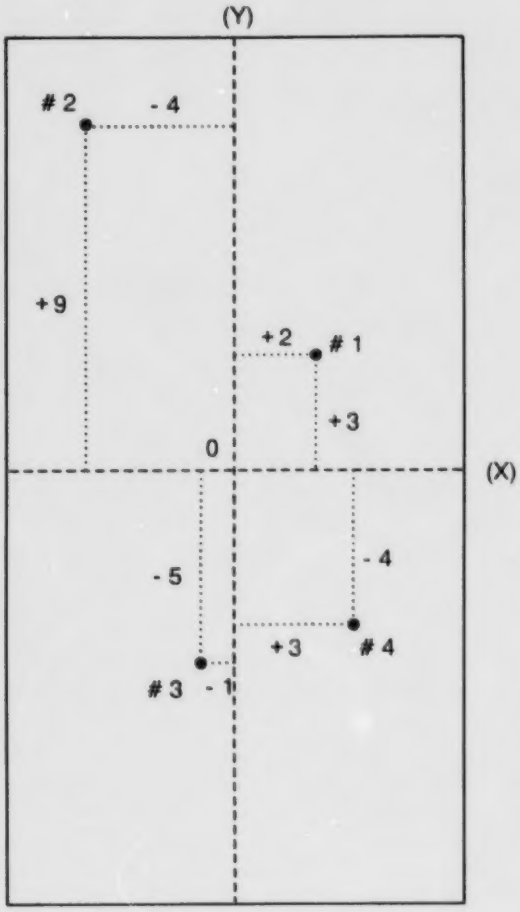
Assessment type: (Col. 1-2)	Same as ARNEWS form number expressed as two-digit number. 02 signifies form 2 for Particulars for Plot Map.
Plot number: (Col. 3-5)	Record three-digit plot designation, i.e. region-number, e.g. 305.
Date mapped: (Col. 20-25)	Enter as two-digit numbers for year-month-day (in that order), e.g. September 7, 1985 = 850907.
Location:	Location of plot.
Mapped by:	Name(s) of individuals doing work.
Page _ of _:	Completion after last tree is assessed to assist in form handling.
Tree number: (Col. 33-36)	Record as four-digit number, e.g. tree 57 = 0057.
Location of the tree: (Col. 37-39 and Col. 40-42)	Determine the exact location of the tree by measuring the distances appropriate to the method of mapping used. Enter as three-digit number to the nearest 0.1 m, e.g. 7.2 m = 07.2. Two alternative methods are described below.

The "Bearing Method"

1. Experience shows that an easy way to map trees is on a 1/8 of the plot sector basis, doing one sector at a time. With a measuring tape along the long center line from the center post (the bearing indicating the direction), the longest possible right angle distance to be measured is 5 m. At these distances the 90° can be estimated and the single bearing taken is necessary only to indicate which side of the center line the 1/8 sector is. Regardless of the method used all numbered trees are to be mapped.
2. Determine distances and record to the nearest 0.1 m to the center of the tree. Note: ensure the "page _ of _" section of all sheets is completed after information on the last tree is entered.
3. Disregard +/- marks on the form when using this method.

The "Coordinates Method"

1. The longer center line is considered the Y axis, the shorter one the X axis. The plot center consequently has coordinates Y = 0, X = 0.
2. Measure the distance of each tree along the two axes, using the + and - designations as appropriate and as illustrated.



						(Y)				(X)		
Tree Number Numéro de l'arbre					Distance along Center Line (m) Distance le long de la ligne de centre				Distance from Center Line (m) Distance à partir de la ligne de centre			
33	34	35	36	±	37	38	39	±	40	41	42	
0	0	0	1	+	0	3	0	+	0	2	0	
0	0	0	2	+	0	9	0	-	0	4	0	
0	0	0	3	-	0	5	0	-	0	1	0	
0	0	0	4	-	0	4	0	+	0	3	0	

3. Determine distances and record to the nearest 0.1 m to the center of the tree. Note: ensure the "page _ of _" section of all sheets is completed after information on the last tree is entered.
4. Disregard "Bearing from center post" and "Bearing from center line" on the form when this method is used.

PLOT TREE DATA

ARNEWS Form 3

A 5-yr procedure involving the characterization of all on-plot trees. Provides a description of trees and the stand.

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PLOT TREE DATA (Five-Year Assessment)
ACID RAIN - NATIONAL EARLY WARNING SYSTEM

DONNÉES SUR LES ARBRES DE LA PARCELLE (Évaluation quinquennale)
DISPOSITIF NATIONAL D'ALERTE RAPIDE DES PLUIES ACIDES

ARNEWS DNARPA 3

Assessment Type / Type d'évaluation: 0 3 (1 2)
Plot No. / Nº de la parcelle: (3 4 5)
Assessment Date / Date de l'évaluation: (20 21 22 23 24 25)

Location/Localisation

Assessed By/Évaluation faite par

Page of / de

Tree Number / Numéro de l'arbre				Tree Species / Essence			Dominance	DBH / DHP (cm)				Live Crown Width / Largeur de la cime vivante (m)						Tree Height / Hauteur de l'arbre (m)			Live Crown Length / Longueur de la cime vivante (m)			Remarks / Remarques
												N - S			E - W E - O									
33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	

AGR 3349 (87 94)

Canada

PLOT TREE DATA

ARNEWS Form 3

Assessment type: (Col. 1-2)
Same as ARNEWS form number expressed as two-digit number. 03 signifies form 3 for Plot Tree Data (5-yr assessment).

Plot number: (Col. 3-5)
Record three-digit plot designation, i.e. region-number, e.g. 305.

Assessment date: (Col. 20-25)
Enter as two-digit numbers for year-month-day (in that order), e.g. September 7, 1985 = 850907.

Location:
Name the plot by location to avoid coding error and to assist in hand sorting.

Assessed by:
The name(s) of individual(s) doing the field assessment.

Page _ of _:
Complete after last tree is assessed to assist in form handling.

Tree number: (Col. 33-36)
Record as four-digit number, e.g. tree 57 = 0057.

Tree species: (Col. 37-39)
Use standard FIDS species designation, e.g. balsam fir = 003.

Dominance: (Col. 40)
Use standard FIDS definitions and record as:

1 = dominant
2 = codominant
3 = intermediate
4 = suppressed

DBH: (Col. 41-44)
Measure at 1.3 m from the midpoint of the ground (slope). Record as four-digit number to nearest 0.1 cm, e.g. DBH = 35.7 cm = 035.7.

Live crown width: (Col. 45-47 and Col. 48-50)
Measure the distance from the edge of the longest live branch in the northerly direction to the edge of the longest branch in the southerly direction. The tape in most instances will touch the base of the tree. The edge of the longest branch is determined by standing under the branch and estimating the measuring point. Record as a three-digit number to nearest 0.1 m., e.g. 7.4 m = 07.4. Repeat procedure for east-west measurement. (The measurement of crown diameter along two cardinal directions will often introduce some inaccuracy because these directions will probably not coincide with maximum-minimum diameters. Because of the need for comparability between measurements where the detection of change is the objective, the standardization of the measurement is deemed more important, and less time-consuming, than the subjective selection of diameters to be measured.)

Tree height: (Col. 51-53)
Obtain with tree height measuring device and determine to nearest 0.5 m. Record as three-digit number, e.g. 9.2 m = 09.0. Measure the height of either all trees on an ARNEWS plot or up to 30 trees per species, whichever is less. (Tree height is re-measured and the average leader growth determined for the 5-yr. Precise determination of actual annual leader growth would require cutting down trees, which is against the no stand disturbance principle.)

Live crown length: (Col. 54-56)
Living crown height is defined as that part of the crown that is continuous from the living top to the lowest living branch, regardless of whether there is a complete whorl of branches on the up-slope side of the tree. Disregard disjoined lower living branches. Measure length of live crown with tree-measuring device and determine to nearest 0.5 m, measure from base of live crown to the top of the tree and if there is a bare top its length is subtracted from measurement. Record as three-digit number, e.g. 7.5 m = 07.5. (Often

there are adventitious or epicormic branches along the stem or at the major branches of the tree, such as elms; although the presence of these green tufts is noteworthy, they are not considered part of the live crown height.)
Note: Ensure the "page __ of __" section of all sheets is completed after information on the last tree is entered.

PLOT TREE ASSESSMENT

ARNEWS Form 4

An annual procedure involving all on-plot trees.

The assessment is normally done towards the end of the field season after growth is completed — most insects and annual diseases have completed their development and caused whatever damage they are likely to incur and before fall coloration interferes with observations of visual symptoms. It is useful to conduct detailed assessments of off-plot trees (ARNEWS forms 7,8,9,10) before the assessment of on-plot trees, because this information will facilitate dealing with most of the symptoms observed on on-plot trees.

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PLOT TREE ASSESSMENT (ANNUAL) ACID RAIN - NATIONAL EARLY WARNING SYSTEM

ÉVALUATION DES ARBRES DE LA PARCELLE (ANNUELLE) DISPOSITIF NATIONAL D'ALERTE RAPIDE DES PLUIES ACIDES

ARNEWS DNARPA 4

Assessment Type / Type d'évaluation: 0 4 (1 2)

Plot No. / N° de la parcelle: (3 4 5)

Assessment Date / Date de l'évaluation: (20 21 22 23 24 25)

Location/Localisation

Assessed By/Évaluation faite par

Page of / de

Tree Number / Numéro de l'arbre				Tree Species / Essence			Tree Type / Type d'arbre	Tree Condition / État de l'arbre		Bare Top Length (m) / Longueur de la cime morte		Branch Condition / État des branches	Storm Damage/Open Grown / Dos à des tempêtes	Current defoliation / Défoliation courante	Acid Rain Symptoms / Symptômes de pluies acides								Seed Production / Prod. de graines	Foliage Damage / Dommages au feuillage				Woody Tissue Damage / Dommages aux tissus ligneux				Acid Rain Symptoms / Sympt de pluies acides	Remarks / Remarques
																								Insect / Insecte		Disease / Maladie		Insect / Insecte		Disease / Maladie		
33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	
																								T	L/A	T	L/A	T	D	T	D		

PLOT TREE ASSESSMENT

ARNEWS Form 4

Assessment type: (Col. 1-2)
Same as ARNEWS form number expressed as two-digit number. 04 signifies form 4 for Plot Tree Assessment (annual).

Plot number: (Col. 3-5)
Record three-digit plot designation, i.e region - number; e.g. 305.

Assessment date: (Col. 20-25)
Enter as two-digit numbers for year-month-day (in that order), e.g. September 7, 1985 = 850907.

Location:
Name the plot by location to avoid a coding error and to aid in hand sorting.

Assessed by:
The name(s) of individual(s) doing the field assessment.

Page_of_:
Complete after last tree is assessed to assist in form handling.

Tree number: (Col. 33-36)
Record as four-digit number, e.g. tree 57 = 0057.

Tree species: (Col. 37-39)
Use standard FIDS species designations, e.g. balsam fir = 003.

Tree type: (Col. 40)
Enter:

1. Conifer
2. Hardwood

Tree condition: (Col. 41-42)
Tree condition is determined for all tagged trees using the conifer or hardwood condition classification system which follows. For the purpose of this classification, defoliation is defined as foliage missing for whatever reason from the "normal" foliage complement of the tree, e.g. spruces normally retain their needles for 7 yr, pines for 4 yr. In assessing "total defoliation," the missing amount of those needle age groups is assessed, e.g. an eastern white pine tree with only current and last year's foliage present would be classed as being 50% defoliated (04).
All dead trees for the initial, base year assessment are classed as 08 (new dead tree) and classes regarding removal of trees from the stand are not applicable. (They are included here because this phase of plot assessment will be an annual procedure when these classes are valid.)
Record as two-digit number (The "tree type" column will separate the conifer and the hardwood, e.g. 05 for a conifer is 51-75% total defoliation but for a hardwood tree it is "dead branches present on up to 50% of the crown.")

CONIFER CONDITION CLASSIFICATION

01 = Healthy and no defoliation.
02 = Healthy and only current defoliation.
03 = Current and some older foliage damaged, but total defoliation less than 25%.
04 = 26-50% total defoliation.
05 = 51-75% total defoliation.
06 = 76-90% total defoliation.
07 = More than 90% total defoliation.
08 = New dead tree - tree died since last assessment.
09 = Dead - all standing dead trees recorded in class 08 during the last assessment are to be shifted to class 09.
10 = Class 08 or 09 tree removed from stand since last assessment.
11 = Trees rated in class 10 at last assessment are to be shifted to class 11.
12 = Living tree removed from stand since last assessment.
13 = Trees rated in class 12 at last assessment are to be shifted to class 13.

HARDWOOD CONDITION CLASSIFICATION

01 = Normal healthy tree.
02 = Foliage thin, off-color, particularly in upper crown, but no bare twigs or branches.
03 = Dead twigs present but no dead branches. Dead twigs occur at the ends of the branches, usually in the top of the crown, and from about 0.5 to 1.0 m from the edge of the crown. In this and subsequent categories the foliage is usually, but not necessarily, weak.
04 = Dead branches present on up to 25% of the crown.
05 = Dead branches present on up to 50% of the crown.
06 = More than 50% of the crown is dead but some living branches still present on the tree.
07 = More than 50% of the crown is dead. No living branches present except small adventitious ones, usually at the base of the crown or on the stem.
08 = Tree newly dead or dying (cambium green at breast height).
09 = Dead tree - all standing dead trees recorded in class 08 during the last assessment are to be shifted to class 09.
10 = Class 08 or 09 tree removed from stand since last assessment.
11 = Trees rated in class 10 at last assessment are to be shifted to class 11.
12 = Living tree removed from stand since last assessment.
13 = Trees rated in class 12 at last assessment are to be shifted to class 13.
14 = As in 08 but cambium dry at breast height, most of the fine twigs still adhering.
15 = Tree dead several years, most of the twigs and smaller branches gone.

Bare top length: (Col. 43-44)
Estimate bare top length for conifers and the extent of top dieback for hardwoods to the nearest 0.5 m and record as two-digit number. Bare tops 10.0 m long or more are to be recorded as 9.9.

Branch condition: (Col. 45)
Record as one-digit number as follows:
1 = Healthy.
2 = Spiked appearance. (This may occur on spruce when lateral buds have been destroyed by defoliating insects.)
3 = Dead branch tips.
4 = Dead branches within live crown.
5 = Tree dying.

Storm damage: (Col. 46)
Record as one-digit number as follows:
1 = Negative when plot established.
2 = Present when plot established.
3 = New damage since last assessment.
4 = Damage was present at last assessment.
5 = Tree is dead.

At the time of plot establishment only codes 1 and 2 apply. At second assessment "2" codes are shifted to class 4 or 5; class 3 or 5 must have been preceded by class 1 at establishment. At subsequent assessments class 3 of the previous assessment is shifted to class 4 or 5. The "extra" classes are needed to facilitate analysis.

Current defoliation:
Based on examination of foliage of hardwoods and on current shoots of conifers. Insects feeding on older foliage of conifers (e.g. some sawflies on pine) are not assessed here. Do an ocular estimate at several places within the live crowns and record as a one-digit number as follows:

0 = 0%
1 = 1- 10%
2 = 11-20%
3 = 21-40%
4 = 41-60%
5 = 61-80%
6 = 81-99%
7 = 100%
8 =
9 =

Foliage color (and other A.R. symptoms): (Col. 48-55)

This section is reserved for recording discoloration and other symptoms due to unknown (abiotic) causes. Disregard symptoms caused by or attributable to insects and/or diseases (fungi). The tree is inspected through binoculars and up to four conditions can be recorded as two-digit numbers.

The observer is to use the ARNEWS Symptomology Manual and record the two-digit number under a photograph showing the symptoms that appear on the branch (or tree). If a suitable photograph is not found, then the symptom observed is recorded as a two-digit number selected from the following list. It is expected that when possible these symptoms will be photographed so the Symptomology Manual can be expanded to include the described symptom. (A two-digit number will be assigned and appropriate photographs distributed annually for inclusion and use throughout the ARNEWS system.) The classes are not mutually exclusive - several may be applicable to the same tree. Some classes apply to both conifers and hardwoods whereas others are applicable to one tree type only. 00 should be coded in all columns not used for recording symptoms in this section.

00 = Green (normal): or no undetermined abiotic symptoms.
85 = Chlorotic (yellow green).
86 = Yellow (current foliage).
87 = Chlorotic yellow (old foliage) (for tree assessment only).
88 = Mottled (yellow, brown, or red spots).
89 = Marginal tip on edge discoloration (brown, red, or yellow.)
90 = Needle banding of all needles per fascicle.
91 = Needle banding of some needles per fascicle.
92 = Spotted - dead areas on leaves or needles.
93 = Interveinal discoloration.
94 = Entire needle or leaf red or brown.
95 = Needle tips dead and broken off at same length per fascicle.
96 = Needles or leaves on entire shoot or branch red or brown.

Seed (cone) production: (Col. 56)

Recorded as one-digit number under the first tree of each species and the rating refers to all dominant and codominant trees of that species on the plot. The classification system selected refers to the stand rather than the single trees. The time to record this parameter will depend on the tree species, and the observation should be made during the visit most suitable to the given species. Use one of the following codes:

0 = None - no cones or seed on seed trees.
1 = Very light - few cones or seed on less than 25% of seed trees.
2 = Light - few cones or seed on more than 25% of seed trees.
3 = Medium - many cones or seed on 25-50% of seed trees.
4 = Heavy - many cones or seed on more than 50% of seed trees.

Forest pest conditions: (Col. 57-64)

Insects and diseases on plot trees are assessed only generally because of the policy of no sampling. Precise information on the identity of organisms and the level of damage is obtained on off-plot trees and related to the plot as a unit rather than to each individual tree. Complete ARNEWS forms 7,8,9, and 10 before proceeding with this section.

On on-plot trees only the most common insect and the most common disease are identified by the type (group) of effect caused and the overall damage categoried. When two or more organisms are equally common this is so indicated.

The foliage and the woody parts of the tree are assessed independently. "Damage" is rated in genera! terms.

This assessment may be done by staggering the observations during the field season according to the life cycle of the different major groups of organisms.

Type of foliage insects: (Col. 57)

Identify the type of the most common insect present (or that has caused identifiable "damage") on foliage, buds, or current shoots and record as a one-digit number under T (type). When two or more organisms are equally common this is so indicated.

0 = None recorded.
1 = Free-feeding defoliator (spruce budworm, western hemlock looper, forest tent caterpillar, etc.).
2 = Leafroller, leafminer, leaf skeletonizer, needleminer (maple leafroller, birch leafminer, birch skeletonizer, lodgepole needleminer, etc.).
3 = Tent or nestmaker (eastern tent caterpillar, spruce webspinning sawfly, etc.).
4 = Budminer, shootminer (hard maple budminer, balsam shootboring sawfly, etc.).
5 = Gallmaker (balsam gall midge, maple bladder gall, etc.).
6 = Sucking insects (woolly alder aphid, balsam twig aphid, etc.).
7 =
8 = Other - specify under remarks.
9 = Two or more species in equal numbers.

Level of foliage damage by insects: (Col. 58)

Assess overall foliage damage by insects and record as one-digit number. Use standard FIDS definitions for the following under L (level).

0 = None visible.
1 = Trace.
2 = Light.
3 = Moderate.
4 = Severe.

Type of foliage diseases: (Col. 59)

Identify the type of the most common disease present (or that has caused identifiable "damage") and record as one-digit number under T (type). When two or more organisms are equally common this is so indicated.

0 = None recorded.
1 = Needle rust, leaf rust.
2 = Needle cast.
3 = Needle/leaf blight.
4 = Leaf spot.

5 = Anthracnose.
6 = Leaf blisters.
7 = Physical damage (wind, hail).
8 = Other - specify under remarks.
9 = Two or more species in equal numbers.

Level of foliage damage by diseases:
(Col. 60)

Assess overall foliage damage and record as one-digit number. Use standard FIDS definitions for the following under L (level).
0 = None visible.
1 = Trace.
2 = Light.
3 = Moderate.
4 = Severe.

Type of woody tissue insects:
(Col. 61)

Identify the type of the most important insect likely the most damaging to the health of the tree (e.g. eastern larch beetle would probably kill the tree much before appreciable damage would be caused by the larch shoot moth even if the latter is more common). Record as one-digit number under T (type). When two or more organisms are equally common this is so indicated.
0 = None recorded.
1 = Sucking insect (balsam woolly adelgid, beech scale, etc.).
2 = Gallmaker (pine gall weevil, gouty oak gall wasp, etc.).
3 = Tip borer, shoot borer (white pine weevil, larch shoot moth, etc.).
4 = Bark beetles (mountain pine beetle, spruce beetle, etc.).
5 = Woodboring insects (whitespotted sawyer, blue horntail, etc.).
6 = Root and root collar insects (root collar weevil, claycolored root weevil, etc.).
7 =
8 = Other - specify under remarks.
9 = Two or more species in equal numbers.

Damage by woody tissue insects:
(Col. 62)

Assess the damage to the tree and record as one-digit number. Use the most appropriate class and record under D (damage).
0 = None recorded.
1 = Sucking insects present, little apparent affect on the tree.
2 = Sucking insects present; tree in a chronic state of decline, stem cankering, gouty twigs, or flat top may be present.
3 = Galimakers, tip borers, or shoot borers present, little apparent affect on tree.
4 = Gallmakers, tip borers, or shoot borers present, tree heavily damaged or disfigured.
5 = Bark beetles and/or woodboring insects present, tree alive.
6 = Root and/or root collar insects present, little apparent affect on tree.
7 = Root and/or root collar weevil present, tree in a state of decline.
8 = Other - specify under remarks.
9 = Tree dead.

Type of woody tissue diseases: (Col. 63)

Identify the type of the most important disease likely the most damaging to the health of the tree (e.g. root rot would probably kill the tree before witches' broom would cause much growth loss). Record as one-digit number under T (type). When two or more organisms are equally common this is so indicated.

0 = None recorded.
1 = Stem and branch rust (not globase) (*Cronartium*).
2 = Stem canker (*Atropellis, Hypoxylon, Nectria*, etc.).
3 =
4 = Twig canker, branch canker (*Cytospora, Scleroderris*, etc.).
5 = Witches' broom, mistletoe.
6 = Fruiting bodies of stem decay fungi.
7 = Root rot (*Armillaria, Poria, Polyporus tomentosus*, etc.).
8 = Other - specify under remarks (e.g. Sirococcus shoot blight).
9 = Two or more species of equal importance.

Damage by woody tissue diseases: (Col. 64)

Assess the damage to the tree and record as one-digit number. Use the most appropriate class and record under D (damage).

0 = None recorded.
1 = Stem deformation.
2 = Twig dieback, twig mortality.
3 = Branch dieback, branch mortality.
4 = Wilt.
5 = Decay.
6 = Witches' broom, swelling, gall.
7 =
8 = Other - specify under remarks.
9 = Tree dead.

Degree of A.R. symptoms:(Col. 65)

Indicate by a one-digit number the amount of foliage affected by those disorders listed under A. R. symptoms (col. 48-55). Use standard FIDS definitions for the following terms.

0 = None visible.
1 = Trace.
2 = Light.
3 = Moderate.
4 = Severe.

Remarks:

Use this section as needed for observations such as hardwood leaves smaller than normal, the identity of insects or diseases when 9 was coded, or for providing reference to additional information elsewhere.

REGENERATION SURVEY

ARNEWS Form 5

An annual on-plot procedure.

Surveys are conducted on the subplots. The three 1-m^2 subplots represent the absolute minimum that must be done. Since their total area constitutes less than 1% of the plot surface, it is suggested that their total number be increased. Provisions made in the coding system allow for the accommodation of up to 20 subplots for this purpose on each ARNEWS plot.

All tree species are tallied and all living seedlings 16 cm high and over classified in 10-cm height classes. It is permissible to use dot tally or other similar tally system on the form when doing the assessment, but a summary line with actual figures must be provided for each tree species.

Seedlings less than 16 cm high are not considered. Those seedlings are thought to be nonestablished, with most of their roots in the duff or moss layer rather than in the soil, their survival too strongly dependent on moisture regimes, and their numbers too variable from year to year to be useful in monitoring.

The large number of height classes for seedlings was chosen deliberately for two reasons: (1) the shifting of seedlings from class to class may provide an indicator for growth (other things being equal), and (2) some measurements on regeneration may be incorporated into the system later.

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REGENERATION SURVEY (ANNUAL)
ACID RAIN - NATIONAL EARLY WARNING SYSTEM

RELEVÉ DE LA RÉGÉNÉRATION (ANNUEL)
DISPOSITIF NATIONAL D'ALERTE RAPIDE DES PLUIES ACIDES

ARNEWS DNARPA 5

Assessment Type / Type d'évaluation: 0 5 (1 2)

Plot No. / Nº de la parcelle: (3 4 5)

Assessment Date / Date de l'évaluation: (20 21 22 23 24 25)

Subplot No. / Nº de la sous-parcelle: (26 27)

Location/Localisation

Assessed By/Évaluation faite par

Page of de

Tree Species / Essence			Height Classes (cm) Classes de hauteur																						Total			Remarks / Remarques
			16 - 25		26 - 35		36 - 45		46 - 55		56 - 65		66 - 75		76 - 85		86 - 95		96 - 105		106 - 115		116 - 125		126 - 135		136 - 145					
33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	

AGR 3351 (87-94)

Canada

REGENERATION SURVEY

ARNEWS Form 5

Assessment type: (Col. 1-2)	Same as ARNEWS form number expressed as two-digit number. 05 signifies form 5 for Regeneration Survey (annual).
Plot number: (Col. 3-5)	Record three-digit plot designation, i.e. region- number, e.g. 305.
Assessment date: (Col. 20-25)	Enter as two-digit numbers for year–month–day (in that order), e.g. September 7, 1984 = 840907.
Subplot number: (Col. 26-27)	Enter as two-digit number, e.g. subplot 3 = 03, subplot 15 = 15.
Location:	Name the plot by location to avoid coding error and to aid in hand sorting.
Assessed by:	The name(s) of individual(s) doing the field assessment.
Page_of_:	Complete after last tree is assessed to assist in form handling.
Tree species: (Col. 33-35)	Use standard FIDS species designations, e.g. balsam fir 003.
Height classes: (Col. 36-61)	Regardless of the tally system used the number of seedlings in each height class for each species should be given as two-digit numbers under the appropriate column.
Total: (Col. 62-64)	The total number of seedlings counted for a given species, expressed as three-digit number.
Remarks:	Use as appropriate.

GROUND VEGETATION SURVEY

ARNEWS Form 6

An annual on-plot procedure to be repeated several times during the growing season. A combined list may be produced on completion.

Specimens of ground flora detected on the plot should be collected outside the plot to avoid disturbance. An example of the sample submittal form is included at the end of this section.

Certain species found on the forest floor are known to be sensitive indicators of acid rain. Others react to changes in soil chemistry. Before procedures can be developed for the assessment of this parameter information is necessary on what is present on the plots. Therefore, the initial objective of this procedure is to catalogue the ground flora. Observers can either identify plants present at their regular visits or make the appropriate collections for laboratory identification. The first step is to produce a comprehensive list of plants present on the plot so that indicator species could be selected for specific observations. Under remarks, observations regarding the condition of the plants are expected. Special attention must be paid to leaf color, "pollution" symptoms, pest conditions, etc.

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GROUND VEGETATION SURVEY (ANNUAL)
ACID RAIN - NATIONAL EARLY WARNING SYSTEM

RELEVÉ DE LA COUVERTURE VIVANTE (ANNUEL)
DISPOSITIF NATIONAL D'ALERTE RAPIDE DES PLUIES ACIDES

ARNEWS DNARPA 6

Assessment Type / Type d'évaluation: 0 6 (1 2)

Plot No. / Nº de la parcelle: (3 4 5)

Assessment Date / Date de l'évaluation: (20 21 22 23 24 25)

Subplot No. / Nº de la sous-parcelle: (26 27)

Location/Localisation

Assessed By/Évaluation faite par

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Species / Essences	Remarks / Remarques

Canada

AGR 3352 (87 04)

GROUND VEGETATION SURVEY

ARNEWS Form 6

Assessment type: (Col. 1-2)	Same as ARNEWS form number expressed as two-digit number. 06 signifies form 6 for Ground Vegetation Survey.
Plot number: (Col. 3-5)	Record three-digit plot designation, i.e. region– number, e.g. 305.
Assessment date: (Col. 20-25)	Enter as two-digit numbers for year–month–day (in that order), e.g. September 7, 1984 = 840907.
Subplot number: (Col. 26-27)	Enter 00.
Location:	Name the plot by location to avoid coding error and to aid in hand sorting.
Assessed by:	The name(s) of individual(s) doing the field assessment.
Page_of_:	Complete after last plant is assessed to assist in form handling.

The body of the form is to be filled out as well as possible. Under "species," reference numbers to plant collections may be used if necessary. Since the compilation of the list will involve several visits to the plot, the number of ARNEWS 6 forms relating to a specific subplot will depend on the number of visits. Use a disease folder for plants to be identified, and take samples outside of plot. Forms are provided for details and a copy is to be filled out and enclosed with each sample.

ARNEWS Form 6

Government of Canada / Gouvernement du Canada Canadian Forestry Service / Service canadien des forêts	GROUND VEGETATION SAMPLE SUBMITTAL ACID RAIN - NATIONAL EARLY WARNING SYSTEM	PRÉSENTATION DES ÉCHANTILLONS DE LA COUVERTURE VIVANTE DISPOSITIF NATIONAL D'ALERTE RAPIDE DES PLUIES ACIDES
Plot No. / Nº de la parcelle	Reference Number / Nº de référence	UTM Grid / Quadrillage MTU
Location /Localisation	County / Comté	Province
Collector / Auteur du prélèvement		Date Collected / Date du prélèvement
Remarks / Remarques		

Canada

AGR 3153 (87-04)

DETAILED TREE DATA FOR CONIFERS

ARNEWS Form 7

An annual assessment on off-plot, numbered trees.

Because of the long-range nature of the project, no destructive sampling will be carried out on plot trees. Parameters that require sampling are obtained on off-plot trees and these trees are the same ones from which increment cores were taken. The general guidelines for trees to be assessed are summarized as follows:

1. Five (5), if possible codominant, trees of each species that represent at least 10% of the trees on the plot should be assessed annually, selected from those 10 for which increment cores are available. The other five trees are assessed the following year, thereafter these two groups of five trees are alternated. It may be necessary to select new trees periodically.
2. One mid-crown branch long enough to include 8-yr growth is cut from each tree.
3. Conduct assessment of length measurements after the year's growth has been completed to include current year's information.
4. A separate form will be used to record information for each tree, that is, five sheets per year per tree species.
5. Off-plot numbered trees may be considered as subplots or should be listed on ARNEWS form 13.
6. It is helpful to complete ARNEWS forms 7,8,9, and 10 for off-plot trees before ARNEWS form 4 is done for on-plot trees.

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DETAILED TREE DATA FOR CONIFERS (ANNUAL)
ACID RAIN - NATIONAL EARLY WARNING SYSTEM

DONNÉES DÉTAILLÉES SUR LES CONIFÈRES (ANNUELLES)
DISPOSITIF NATIONAL D'ALERTE RAPIDE DES PLUIES ACIDES

ARNEWS DNARPA 7

Assessment Type / Type d'évaluation: 0 7 (1 2)
Plot No. / Nº de la parcelle: (3 4 5)
Assessment Date / Date de l'évaluation: (20 21 22 23 24 25)
Subplot No. / Nº de la sous-parcelle: (26 27)

Location/Localisation

Assessed By/Évaluation faite par

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Tree Species / Essence: (33 34 35)
Tree Number / Nº de l'arbre: (36 37 38 39)

The insect/disease assessment of the same tree is to be recorded on **ARNEWS 8 - AGR 3355.**

L'évaluation des insectes et des maladies observés sur cet arbre doit être enregistrée sur le formulaire **DNARPA 8 - AGR 3355.**

Shoot Age / Âge de la pousse			Shoot Length (cm) / Longueur de la pousse			Needle Retention % / Rétention des aiguilles			Acid Rain Symptoms of Needle Age Class / Symptômes de pluies acides par classe d'âge des aiguilles								Bud / Bourgeon	Insect(s)	Disease / Maladie	Lichens: hairy / fruticuleux	Lichens: leafy / foliacés	Acid Rain Symptoms / Symptômes de pluies acides	Remarks / Remarques
–	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	
C -	0	0																					
C -	0	1																					
C -	0	2																					
C -	0	3															X						
C -	0	4															X						
C -	0	5															X						
C -	0	6															X						
C -	0	7															X						

Tree Assessment / Évaluation de l'arbre

Tree Condition / État de l'arbre: (61 62)

Current Defoliation Level / Niveau de la défoliation actuelle: (63)

Insect - Disease / Insecte - maladie

on foliage / feuillage: (64)
on twig/branch / rameaux/branches: (65)
on stem / tige: (66)
on root / racines: (67)

Include organisms attacking cones, seeds, and current shoots, with foliage. (Details of pest conditions are to be recorded on **ARNEWS 8 - AGR 3355**).

Les organismes qui s'attaquent aux cônes, aux graines et aux pousses de l'année doivent être comptés parmi ceux du feuillage. (Les détails relatifs aux organismes ravageurs doivent être enregistrés sur le formulaire **DNARPA 8 - AGR 3355**).

Canada

DETAILED TREE DATA FOR CONIFERS

ARNEWS Form 7

Assessment type: (Col. 1-2)	Same as ARNEWS form number expressed as two-digit number. 07 signifies form 7 for Detailed Tree Data for Conifers (annual).
Plot number: (Col. 3-5)	Record three-digit plot designation, i.e. region-number, e.g. 305.
Assessment date: (Col. 20-25)	Enter as two-digit numbers for year-month-day (in that order), e.g. September 7, 1984 = 840907.
Subplot number: (Col. 26-27)	Enter 00 or if these off-plot trees are considered subplots then enter appropriate two-digit number (the first 20 numbers are reserved for 1 m^2 on plot subplots).
Location:	Name the plot by location to avoid coding error and to aid in hand sorting.
Assessed by:	The name(s) of individual(s) doing the field assessment.
Tree species: (Col. 33-35)	Use standard FIDS species designations, e.g. balsam fir 003.
Tree number: (Col. 36-39)	Record as four-digit number, e.g. tree 57 = 0057.
Branch information:	All data for this is taken from the one mid-crown branch. The assessment is carried out on the main shoot only and secondary and other side branches are disregarded. However, conditions may warrant noting various observations such as the main shoot not being formed from the terminal bud due to damage, foliage area of the selected branch, the number of current shoots on the selected branch in relation to area, the percentage of non-green needles for a given needle age class, etc.
Shoot age: (Col. 40-41)	Each shoot age class on the main branch is assessed separately and observations recorded on the appropriate line. Assessments are to be carried back from the current shoot only as far as the accuracy of observations justifies. "Current" refers to growth produced in the year of assessment, development completed, and terminal buds formed.
Shoot length: (Col. 42-44)	Measure and record to the nearest 0.1 cm as a three-digit number, e.g. 7.9 cm = 079. If shoot originated from side terminal, internodal, or opicormic bud, note in remarks.
Needle retention: (Col. 45-47)	Estimate the amount of foliage present for each age group to the nearest 10% and record as a three-digit number, e.g. 100% = 100, 70% = 070, 0% = 000. Rate for as many years for fir and spruce as possible. For pines only the youngest 5 yr are rated. Draw a line from the needle retention columns to the right in row C-5 to indicate that no information is collected. For larch (a deciduous conifer) the line should be drawn in row C-1 as an indicator. For cedars and junipers this section and many others on this form will be omitted because their morphology precludes proper assessment.
Acid rain symptoms of needle age class: (Col. 48-55)	This section is reserved for recording discoloration and other symptoms due to unknown (abiotic) causes. Symptoms caused by or attributable to insects and/or diseases are to be disregarded. Each needle age class is to be assessed independently. Up to four (4) conditions can be recorded as two-digit numbers. The observer is to use the ARNEWS Symptomology Manual and record the two-digit number under a photograph showing the symptoms that appear in the branch (or tree). If a suitable photograph is not found, then the symptom observed is recorded as a two-digit number selected from the

following list. (These symptoms will be photographed when possible so the Symptomology Manual can be expanded to include the described symptom.) Not all symptoms in this list are applicable to conifers but are included for the uniformity of the system. Zeros (00) should be coded in all columns not used for recording symptoms in this section.

00 = Green (normal); or no unexplained abiotic symptoms.
85 = Chlorotic (yellow green).
86 = Yellow (current foliage).
87 = Chlorotic yellow (old foliage) - for tree assessment only.
88 = Mottled (yellow, brown, or red spots).
89 = Marginal tip or edge discoloration (brown, red, or yellow).
90 = Needle banding of all needles per fascicle.
91 = Needle banding of some needles per fascicle.
92 = Spotted = dead areas on leaves or needles.
93 = Interveinal discoloration.
94 = Entire needle or leaf red or brown.
95 = Needle tips dead and broken off at same length per facicle.
96 = Needles or leaves on entire shoot or branch red or brown.

Buds:
(Col. 56)

The buds at the tip of the current year's growth are assessed, and the fate of last year's buds (shoot age C-1) is assessed by examining the shoot that developed (or missing) from these buds. For noteworthy observations regarding other buds (such as a proliferation of auxiliary buds) use the remarks section. Record observations as one-digit number for C-0 and C-1 only as follows:

0 = Not assessed (reason should be given in remarks).
1 = Full normal complement of normal, apparently healthy buds for the species is present. (If normal complement is one disregard classes 2 and 3.)
2 = Terminal bud healthy and at least one but not all side buds damaged, dead, or missing.
3 = Terminal bud healthy and all or most side buds damaged, dead, or missing.
4 = Terminal bud damaged, dead, or missing and all side buds healthy. (If normal complement is one disregard class 5.)
5 = Terminal bud and at least some but not all side buds damaged dead or missing.
6 = All buds damaged, dead, or missing.
7 = More than the full normal complement of buds for the species are present but appear healthy.
8 = More than the full normal complement of buds for the species is present but at least some are damaged, dead, or missing.
9 = Great proliferation of buds at the tip of the shoot, whether healthy or damaged.

Insects:
(Col. 57)

Identify the type of prevalent insect that is present or that causes the "damage" on the needles. Record as one-digit number (specific information

is to be included on form 8). Not all insect types listed here are applicable to conifers but are included as part of the complete system.

0 = None recorded.
1 = Free-feeding defoliator (spruce budworm, western hemlock looper, forest tent caterpillar, etc.)
2 = Leafroller, leafminer, leaf skeletonizer, needleminer (maple leafroller, birch skeletonizer, lodgepole needleminer, etc.).
3 = Tent or nestmaker (eastern tent caterpillar, spruce webspinning sawfly, etc.).
4 = Budminer, shootminer (hard maple budminer, balsam shootboring sawfly, etc.).
5 = Gallmaker (balsam gall midge, maple bladder gall etc.).
6 = Sucking insects (woolly alder aphid, balsam twig aphid, etc.).
7 =
8 = Other - specify under remarks.
9 = Two or more species in equal numbers.

Diseases:
(Col. 58)

Identify the type of the most prevalent disease present on the needles. Record as a one-digit number (specific information is to be included on form 8). Not all disease types listed here are applicable to conifers but are included as part of the complete system.

0 = None recorded.
1 = Needle rust, leaf rust.
2 = Needle cast.
3 = Needle/leaf blight.
4 = Leaf spot.
5 = Anthracnose.
6 = Leaf blisters.
7 = Physical damage (wind, hail).
8 = Other - specify under remarks.
9 = Two or more species in equal numbers.

Lichens:
(Col. 59-60)

Indicate the presence or absence of hair-like (col. 59) and leaf-like (col. 60) lichens as follows:

0 = Absent (not seen).
1 = Present.

Remarks:

Use as needed.

Pest information:

The tree serves as the unit for this part of the assessment, although some of the information may be collected on the branch just examined.

Tree condition:
(Col. 61-62)

For the purpose of this classification defoliation is defined as foliage missing for whatever reason from the "normal" foliage complement of the tree, e.g. spruces normally retain their needles for 7 yr, pines for 4 yr. In assessing "total defoliation," the missing amount of those needle age groups are assessed, e.g. an eastern white pine tree with only current and last year's foliage present would be classed as being 50% defoliated (04).

Record as two-digit number. The appropriate parts of the conifer condition classification system follows.

01 = Healthy and no defoliation.
02 = Healthy and only current defoliation.
03 = Current and some older foliage damaged, but total defoliation less than 25%.
04 = 26–50% total defoliation.
05 = 51–75% total defoliation.
06 = 76–90% total defoliation.
07 = More than 90% total defoliation.

Current defoliation: (Col. 63)

Based on examination of foliage of current shoots only. Backfeeding of insects feeding on older foliage (some pine sawflies) are not assessed here. Do an ocular estimate at several places within the live crown and record as one-digit number as follows:

0 = 0%
1 = 1-10%
2 = 11-20%
3 = 21-40%
4 = 41-60%
5 = 61-80%
6 = 81-99%
7 = 100%

Foliage Pests: (Col. 64)

Record as one-digit number.
0 = Absent (not seen).
1 = Present.

Twig/branch pests: (Col. 65)
Stem pests: (Col. 66)
Root pests: (Col. 67)

Organisms attacking cones, seeds, and current shoots are to be included as "foliage pests."

Degree of A.R. symptoms severity: (Col. 68)

Indicate by a one-digit number the amount of foliage on the branch, for each age group of needles separately, by those disorders listed under A.R. symptoms (col. 48-55). Use standard FIDS definitions for the following terms.

0 = None visible.
1 = Trace.
2 = Light.
3 = Moderate.
4 = Severe.

Remarks:

Use as appropriate.

DETAILED PEST ASSESSMENT ON CONIFERS

ARNEWS Form 8

An annual assessment on off-plot, numbered trees, to be done on the same branch used for ARNEWS form 7.

The form is for recording detailed information on pests on the sample tree. Standard FIDS assessment methods are to be used for establishing level of damage as described below. If more space is required, use another page but do not write on the back of the form.

A separate form will be used to record information for each tree, that is, five sheets per year per tree species.

It is helpful to complete ARNEWS forms 7,8,9, and 10 for off-plot trees before ARNEWS form 4 is done for on-plot trees.

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DETAILED PEST ASSESSMENT ON CONIFERS (ANNUAL) ACID RAIN - NATIONAL EARLY WARNING SYSTEM

ÉVALUATION DÉTAILLÉE DES ORGANISMES RAVAGEURS DES CONIFÈRES (ANNUELLE) DISPOSITIF NATIONAL D'ALERTE RAPIDE DES PLUIES ACIDES

ARNEWS DNARPA 8

Assessment Type / Type d'évaluation: 0 8 (1 2)

Plot No. / N° de la parcelle: (3 4 5)

Assessment Date / Date de l'évaluation: (20 21 22 23 24 25)

Subplot No. / N° de la sous-parcelle: (26 27)

Location/Localisation

Assessed By/Évaluation faite par

Page / de

Tree Species / Essence: (33 34 35)

Tree Number / N° de l'arbre: (36 37 38 39)

Pest Condition / Organismes ravageurs (40 41 42 43 44 45 46)	Tree part / Partie de l'arbre (47)	Insect or disease / Insecte ou maladie (48)	Collector's No Registration No / N° de l'échantillonneur N° d'enregistrement (49 50 51 52)	Count Type / Type de dénombrement (53 54)	Counts, Remarks Dénombrements,remarques	% or Sum % ou somme: Ocular estimate Évaluation oculaire (55 56)	% or Sum % ou somme: Calculation Calcul (57 58)

AGR 1355 (87 04)

Canada

DETAILED PEST ASSESSMENT ON CONIFERS

ARNEWS Form 8

Assessment type: (Col. 1-2)	Same as ARNEWS form number expressed as two-digit number. 08 signifies form 8 for Detailed Pest Assessment on Conifers.
Plot number: (Col. 3-5)	Record three-digit plot designation, i.e. region- number, e.g. 305.
Assessment date: (Col. 20-25)	Enter as two-digit numbers for year-month-day (in that order), e.g. September 7, 1984 = 840907.
Subplot number: (Col. 26-27)	Enter 00 or if these off-plot trees are considered subplots then enter appropriate two-digit number.
Location:	Name the plot by location to avoid coding error and to aid in hand sorting.
Assessed by:	The name(s) of individual(s) doing the field assessment.
Page_of_:	Complete after last tree is assessed to assist in form handling.
Tree species: (Col. 33-35)	Use standard FIDS species designations, e.g. balsam fir 003.
Tree number: (Col. 36-39)	Record as four-digit number, e.g. tree 57 = 0057.
Pest condition: (Col. 40-46)	Record the name of the organism and code in the seven spaces provided.
Tree part: (Col. 47)	Record as one-digit number as follows: 1 = Flower and/or fruit. 2 = Buds. 3 = Old foliage. 4 = New foliage. 5 = New shoot. 6 = Twig and/or branch. 7 = Stem. 8 = Butt. 9 = Root.
Insect or disease: (Col. 48)	Record as one-digit number as follows: 1 = Insect. 2 = Disease.
Collector number & Registration number: (Col. 49-52)	When a collection is made the collector number is recorded in the field on the top line. The registration number is assigned in the lab.
Count type: (Col. 53-54)	Choose the sampling technique from the following list and record as a two-digit number. This is a complete list of methods and some will not be applicable to conifers.

01 Needle counts - current growth.
Count affected over total needles on one side of the current growth of three shoots selected at random from each of three trees. Record individual shoot counts separately and estimate incidence.

02 Needle counts - noncurrent.
Count affected over total needles on one side of the non-current growth of three shoots selected randomly from each of three trees. Record individual shoot count separately. State growth year counted (e.g. 1984, 1983, 1982 growth) and estimate incidence.

03 Shoot counts (current growth or 1-yr-old twigs) coniferous, deciduous.
(a) Examine 25 shoots of each of 3 trees, record number affected over total for each tree. (b) Give an ocular estimate for the stand. Give range, (c) estimate incidence.

04 Branch counts - branch tips.
(a) Examine three whole branches from each of three trees and record number affected over total for each tree. (b) Give ocular estimate for low and high intensity. (c) Estimate incidence.

05 Branch counts - whole branch.
For conditions not localized on branch tips. Count the number of organisms on three whole branches from each of three trees and estimate incidence.

06 Tree counts - coniferous.
Examine 25 trees, if possible, of given species. Tally positive over total. Note whether trees are being killed and the type (e.g. dominant, suppressed).

07 Foliage counts - deciduous.
(a) Examine 25 leaves selected from mid-crown branch tips of each of 3 trees. Record number affected over total. (b) Estimate percent of leaf surface damage or missing for the stand (ocular estimate). Give range, (c) estimate incidence.

08 "Stand" defoliation estimates (only).
For some pests where damage is often extensive and where the organism is not one of our more important forest pests, a single estimate of amount of leaf surface affected will suffice, essentially 07(b). For significant problems use TYPE 07 and estimate incidence.

09 Nest counts.
Count the number of nests along 100 m.

10 Tree counts - deciduous.
Examine 25 trees, if possible, of a given species. Tally positive over total. Note whether trees are being killed and the type (e.g. dominant, suppressed).

11 Beating - 2 m x 3 m.
Deciduous beating samples or tall conifers. Use 3-m pole to sample one side of each of three trees.

12 Beating - 1 m x 1 m.
Conifer beating samples. Use 1-m pole to sample two sides of each of three trees.
13 Other.
14 Not used presently.
15 Cone counts.
Examine 25 cones from each of three trees. Record number affected over total and estimate incidence.

Counts, remarks:	Use as appropriate.
Percent-ocular estimate: (Col. 55-56)	Wherever feasible record as percent affected, e.g. 10, 25, etc.
Percent-percent calculated or sum: (Col. 57-58)	Record as a percent number or sum as dictated by the method.

DETAILED TREE DATA FOR HARDWOODS

ARNEWS Form 9

An annual assessment on off-plot, numbered trees.

Because of the long-range nature of the project no destructive sampling will be carried out on plot trees. Parameters that require sampling are obtained on off-plot trees and these trees are the same ones from which increment cores were taken. The general guidelines for trees to be assessed are summarized as follows:

1. Five (5), if possible codominant, trees of each species that represent at least 10% of the trees on the plot should be assessed annually, selected from those 10 for which increment cores are available. The other five trees are assessed the following year; thereafter these two groups of five trees are alternated. It may be necessary to select new trees periodically.
2. One lower branch long enough to include at least current and previous years' growth is cut from each tree.
3. Conduct assessment of length measurements after the year's growth has been completed to include current year's information.
4. A separate form will be used to record information for each tree, i.e. five sheets per year per tree species.
5. Off-plot numbered trees may be considered as subplots or should be listed on ARNEWS form 13.
6. It is helpful to complete ARNEWS forms 7,8,9, and 10 for off-plot trees before ARNEWS form 4 is done for on-plot trees.

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DETAILED TREE DATA FOR HARDWOODS (ANNUAL) ACID RAIN - NATIONAL EARLY WARNING SYSTEM

DONNÉES DÉTAILLÉES SUR LES FEUILLUS (ANNUELLES) DISPOSITIF NATIONAL D'ALERTE RAPIDE DES PLUIES ACIDES

ARNEWS DNARPA 9

Assessment Type / Type d'évaluation [0 9] (1 2)
Plot No. / Nº de la parcelle [ ] (3 4 5)
Assessment Date / Date de l'évaluation [ ] (20 21 22 23 24 25)
Subplot No. / Nº de la sous-parcelle [ ] (26 27)

Location / Localisation

Assessed By / Évaluation faite par

Leaf No /Nº de la feuille	Portion missing/affected / Portion manquante/touchée	Acid Rain Symptoms / Symptômes de pluies acides	Acid Rain Symptoms Rating / Classement des symptômes de pluies acides	Diseases / Maladies	Insects/insectes
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
X	X	X	X	X	X
av moy					68
	40	41	42	43	44

Tree Species / Essence [ ] (33 34 35)

Tree No. / Nº de l'arbre [ ] (36 37 38 39)

Shoots / Pousses

No Nº	Length (cm) Longueur	Bud Bourgeon
1		
2		
3		
4		
5		
av moy		

(51 52 53 54)

Lichens

on / sur	hairy / fruticuleux	leafy / foliacés	
twig / rameau			55-56
branch / branche			57-58
stem / tige			59-60

Tree Condition / État de l'arbre [ ] (61 62)

Defoliation Level / Niveau de la défoliation [ ] (63)

Insects - Diseases / Insectes - maladies

on foliage / feuillage [ ] (64)
on twig/branch / rameaux/branches [ ] (65)
on stem / tige [ ] (66)
on roots / racines [ ] (67)

Details of pest conditions are to be recorded on **ARNEWS 10 - AGR 3357.**

Les détails relatifs aux organismes ravageurs doivent être enregistrés sur le formulaire **DNARPA 10 - AGR 3357.**

Remarks /Remarques

Canada

AGR 3356 (87/04)

DETAILED TREE DATA FOR HARDWOODS

ARNEWS Form 9

Assessment type: (Col. 1-2)	Same as ARNEWS form number expressed as two-digit number. 09 signifies form 9 for Detailed Tree Data for Hardwoods (annual).
Plot number: (Col. 3-5)	Record three-digit plot designation, i.e. region-number, e.g. 305.
Assessment date: (Col. 20-25)	Enter as two-digit numbers for year-month-day (in that order), e.g. September 7, 1984 = 840907.
Subplot number: (Col. 26-27)	Enter 00 or if these trees are considered subplots then enter appropriate two-digit number (the first 20 numbers are reserved for 1-m^2 on-plot subplots).
Location:	Name the plot by location to avoid coding error and to aid in hand sorting.
Assessed by:	The name(s) of individual(s) doing the field assessment.
Tree species: (Col. 33-35)	Use standard FIDS species designations, e.g. balsam fir 003.
Tree number: (Col. 36-39)	Record as four-digit number, e.g. tree 57 = 0057.
Branch information:	All information for this is taken from the one lower branch. The assessment is carried out on the main shoot and secondary and other side branches are to be disregarded. However, conditions may warrant noting various observations.
Foliage information:	Randomly select 25 leaves from the foliage complement of the cut lower branch and assess each one separately for the "table."
Portion missing/affected: (Col. 40)	Visually estimate to the nearest 10% of leaf surface missing (probably chewed by an insect or affected to such a degree that its photosynthetic ability is destroyed (leaf spot, anthracnose, " acid rain" type browning, etc.). Express the estimated loss as a single-digit number and record (e.g. a healthy, green, complete leaf has no loss and is entered as 0, a half chewed leaf has 50% loss and is entered as 5). Both 90% loss and total loss (only petiole is left) are entered as 9. The "average" is entered in col. 40.
Acid rain symptoms: (Col. 41-48)	This section is reserved for recording discoloration and other symptoms due to unknown (abiotic) causes. Symptoms caused by or attributable to insects and/or diseases are to be disregarded. Each leaf is to be assessed independently. Up to four (4) conditions can be recorded as two-digit numbers. The observer is to use the ARNEWS Symptomology Manual and record the two-digit number under a photograph showing the symptoms that appear on the branch (or tree). If a suitable photograph is not found then the symptom observed is recorded as a two-digit number selected from the following list. (It is expected that when possible these symptoms will be photographed so the Symptomology Manual can be expanded to include the described symptom.)

Not all symptoms on the list are applicable to hardwoods but are included here for the uniformity of the system. Zeros (00) should be coded in all columns not used for recording symptoms in this section (e.g. the leaf is completely brown due to anthracnose).
After all leaves are assessed select the four (4) most frequently recorded conditions and record these in decreasing order of frequency in col. 41-48 for coding. 00 is part of this calculation but only for the ones occurring in the first of the four columns of symptoms.

00 = Green (normal); or no unexplained abiotic symptoms.
85 = Chlorotic (yellow green).
86 = Yellow (current foliage).
87 = Chlorotic yellow (old foliage) - for tree assessment only.
88 = Mottled (yellow, brown, or red spots).
89 = Marginal tip or edge discoloration (brown, red, or yellow).
90 = Needle banding of all needles per fascicle.
91 = Needle banding of some needles per fascicle.
92 = Spotted = dead areas on leaves or needles.
93 = Interveinal discoloration.
94 = Entire needle or leaf red or brown.
95 = Needle tips dead and broken off at same length per fascicle.
96 = Needles or leaves on entire shoot or branch red or brown.

Insects:
(Col. 49)

Identify the type of prevalent insect that is present or that causes the "damage" on the leaves. Record as one-digit number. (Specific information is to be included on form 8.) Not all insect types listed below are applicable to hardwoods but are included as part of the complete system.

0 = None recorded.
1 = Free-feeding defoliator (spruce budworm, western hemlock looper, forest tent caterpillar, etc.).
2 = Leafroller, leafminer, leaf skeletonizer, needleminer (maple leafroller, birch skeletonizer, lodgepole needleminer, etc.).
3 = Tent or nestmaker (eastern tent caterpillar, spruce webspinning sawfly, etc.).
4 = Budminer, shootminer (hard maple budminer, balsam shootboring sawfly, etc.).
5 = Gallmaker (balsam gall midge, maple bladder gall, etc.).
6 = Sucking insects (woolly alder aphid, balsam twig aphid, etc.).
7 =
8 = Other - specify under remarks.
9 = Two or more species in equal numbers.

Diseases:
(Col. 50)

Identify the type of the most prevalent disease present on the leaves. Record as a one-digit number. (Specific information is to be included on form 8.) Not all disease types listed here are applicable to hardwoods but are included as part of the complete system. After all leaves are assessed, select the most frequent code in the column and record in col. 50 for coding.

0 = None recorded.
1 = Needle rust, leaf rust.
2 = Needle cast.
3 = Needle/leaf blight.
4 = Leaf spot.
5 = Anthracnose.
6 = Leaf blisters.
7 = Physical damage (wind, hail).
8 = Other - specify under remarks.
9 = Two or more species of equal importance.

Shoot length: (Col. 51-53)

Measure and record (in centimetres) the length of five (5) of the longest current shoots from the same branch, i.e. for hardwoods there is no measuring of previous growth. The "longest shoots" are selected visually from the available new shoots or current growth, preferably originating from last year's leader. Record as three-digit number, e.g. 27 cm = 027. The "average" of the five shoot measurements is entered in col. 51-53 for coding.

Buds: (Col. 54)

The buds at the tip of the five branches measured are assessed for coding. (For noteworthy observations regarding other buds use the remarks section.) Record as one-digit number in the appropriate box then arrive at an "average" condition to be recorded in col. 54 for coding.

0 = Not assessed (reason should be given in remarks).
1 = Full complement of normal, apparently healthy buds for the species present. (If normal complement is one disregard classes 2 and 3.)
2 = Terminal bud healthy; at least one but not all side buds damaged, dead, or missing.
3 = Terminal bud healthy; all or most side buds damaged, dead, or missing.
4 = Terminal bud damaged, dead, or missing; all side buds healthy. (If normal complement is one disregard class 5.)
5 = Terminal bud and at least some but not all side buds damaged, dead, or missing.
6 = All buds damaged, dead, or missing.
7 = More than the full normal complement of buds for the species are present but appear healthy.
8 = More than the full normal complement of buds for the species is present, but at least some are damaged, dead, or missing.
9 = Great proliferation of buds at the tip of the shoot, whether healthy or damaged.

Lichens: (Col. 55-60)

Indicate whether hair-like or leaf-like lichens are present or absent on the twigs (col. 55-56), the branches (col. 57-58), or the stem (col. 59-60), as follows:

0 = Absent (not seen).
1 = Present.

Pest information:

The tree serves as the unit for this part of the assessment, although some of the information may be collected on the branch just examined.

Tree condition: (Col. 61-62)

For the purpose of this classification, defoliation is defined as foliage missing for whatever reason from the "normal" foliage complement of the

tree. Record as two-digit number. The appropriate parts of the hardwood classification system follow:

01 = Normal healthy tree.
02 = Foliage thin, off-color, particularly in upper crown, but no bare twigs or branches.
03 = Dead twigs present but no dead branches. Dead twigs occur at the ends of the branches, usually in the top of the crown, and from about 0.5 to 1.0 m from the edge of the crown. In this and subsequent categories the foliage is usually, but not necessarily, weak.
04 = Dead branches present on up to 25% of the crown.
05 = Dead branches present on up to 50% of the crown.
06 = More than 50% of the crown is dead but some living branches still present on the tree.
07 = More than 50% of the crown is dead. No living branches present except small adventitious ones, usually at the base of the crown or on the stem.

Defoliation level: (Col. 63)

Do an ocular estimate at several places on the tree and record defoliation as a one-digit number as follows:

0 = 0%
1 = 1-10%
2 = 11-20%
3 = 21-40%
4 = 41-60%
5 = 61-80%
6 = 81-99%
7 = 100%

Foliage pests: (Col. 64)
Twig/branch pests: (Col. 65)
Stem pests: (Col. 66)
Root pests: (Col. 67)

Record as one-digit number. Details on insects and diseases are recorded on form 10.

0 = Absent (not seen).
1 = Present.

Degree of A.R. symptoms severity: (Col. 68)

Indicate by a one-digit number the amount of foliage (in this case the individual leaf) affected by those disorders listed under A.R. symptoms (col. 41-48). Use standard FIDS definitions for the following terms:

0 = None visible.
1 = Trace.
2 = Light.
3 = Moderate.
4 = Severe.

Remarks:

Use as appropriate.

DETAILED PEST ASSESSMENT ON HARDWOODS

ARNEWS Form 10

An annual assessment on off-plot, numbered trees, to be done on the same branch used for ARNEWS form 9.

The form is for recording detailed information on pests on the sample tree. Use standard FIDS assessment methods for establishing level of damage as described here. If more space is required use another page, but do not write on the back of the form.

A separate form will be used to record information for each tree, that is, five sheets per year per tree species.

It is helpful to complete ARNEWS forms 7,8,9, and 10 for off-plot trees before ARNEWS form 4 is done for on-plot trees.

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DETAILED PEST ASSESSMENT ON HARDWOODS (ANNUAL)
ACID RAIN - NATIONAL EARLY WARNING SYSTEM

ÉVALUATION DÉTAILLÉE DES ORGANISMES RAVAGEURS DES FEUILLUS (ANNUELLE)
DISPOSITIF NATIONAL D'ALERTE RAPIDE DES PLUIES ACIDES

ARNEWS DNARPA 10

Assessment Type / Type d'évaluation: 1 0 (1 2)

Plot No. / Nº de la parcelle: (3 4 5)

Assessment Date / Date de l'évaluation: (20 21 22 23 24 25)

Subplot No. / Nº de la sous-parcelle: (26 27)

Location/Localisation

Assessed By/Évaluation faite par

Page of / de

Tree Species / Essence: (33 34 35)

Tree Number / Nº de l'arbre: (36 37 38 39)

Pest Condition / Organismes ravageurs (40 41 42 43 44 45 46)	Tree part / Partie de l'arbre (47)	Insect or disease / Insecte ou maladie (48)	Collector's No / Registration No / Nº de l'échantillonneur / Nº d'enregistrement (49 50 51 52)	Count Type / Type de dénombrement (53 54)	Counts, Remarks / Dénombrements, remarques	% or Sum / % ou somme: Ocular estimate / Évaluation oculaire (55 56)	% or Sum / % ou somme: Calculation / Calcul (57 58)

Canada

AGR 3357 (87 04)

DETAILED PEST ASSESSMENT ON HARDWOODS

ARNEWS Form 10

Assessment type: (Col. 1-2)	Same as ARNEWS form number expressed as two-digit number. 10 signifies form 10 for Detailed Pest Assessment on Hardwoods.
Plot number: (Col. 3-5)	Record three-digit plot designation, i.e. region-number, e.g. 305.
Assessment date: (Col. 20-25)	Enter as two-digit numbers for year-month-day (in that order), e.g. September 7, 1984 = 840907.
Subplot number: (Col. 26-27)	Enter as two-digit number, e.g. subplot 3 = 03, subplot 15 = 15.
Location:	Name the plot by location to avoid coding error and to aid in hand sorting.
Assessed by:	The name(s) of individual(s) doing the field assessment.
Page_of_:	Complete after last tree is assessed to assist in form handling.
Tree species: (Col. 33-35)	Use standard FIDS species designations, e.g. balsam fir 003.
Tree number: (Col. 36-39)	Record as four-digit number, e.g. tree 57 = 0057.
Pest condition: (Col. 40-46)	Record the name of the organism and code in the seven spaces provided.
Tree part: (Col. 47)	Record as one-digit number as follows: 1 = Flower and/or fruit. 2 = Buds. 3 = Old foliage. 4 = New foliage. 5 = New shoot. 6 = Twig and/or branch. 7 = Stem. 8 = Butt. 9 = Root.
Insect or disease: (Col. 48)	Record as one-digit number as follows: 1 = Insect. 2 = Disease.
Collector number & Registration number: (Col. 49-52)	When a collection is made the collector number is recorded in the field on the top line. The registration number is assigned in the lab.

Count type:
(Col. 53-54)

Choose the sampling technique from the following list and record as a two-digit number. This is a complete list of methods and some will not be applicable to hardwoods.

01 Needle counts - current growth.
Count affected over total needles on one side of the current growth of three shoots selected at random from each of three trees. Record individual shoot counts separately and estimate incidence.

02 Needle counts - noncurrent.
Count affected over total needles on one side of the noncurrent growth of three shoots selected at random from each of three trees. Record individual shoot count separately. State growth year counted (e.g. 1984, 1983, 1982 growth) and estimate incidence.

03 Shoot counts (current growth or 1-yr-old twigs) - coniferous, deciduous. (a) Examine 25 shoots of each of 3 trees, record number affected over total for each tree. (b) Give an ocular estimate for the stand. Give range (c) and estimate incidence.

04 Branch counts - branch tips.
(a) Examine three whole branches from each of three trees and record number affected over total for each tree. (b) Give ocular estimate for low and high intensity. (c) Estimate incidence.

05 Branch counts - whole branch.
For conditions not localized on branch tips. Count the number of organisms on three whole branches from each of three trees and estimate incidence.

06 Tree counts - coniferous.
Examine 25 trees, if possible, of given species. Tally positive over total. Note whether trees are being killed and the type (e.g. dominant, suppressed).

07 Foliage counts - deciduous.
(a) Examine 25 leaves selected from mid-crown branch tips

of each of 3 trees. Record number affected over total. (b) Estimate percent of leaf surface damage or missing for the stand (ocular estimate). Give range (c) and estimate incidence.

08 "Stand" defoliation estimates (only).
For some pests where damage is often extensive and where the organism is not one of our more important forest pests, a single estimate of amount of leaf surface affected will suffice, essentially 07(b) above. For significant problems use TYPE 07 and estimate incidence.

09 Nest counts.
Count the number of nests along 100 m.

10 Tree counts - deciduous.
Examine 25 trees, if possible, of a given species. Tally positive over total. Note whether trees are being killed and the type (e.g. dominant, suppressed).

11 Beating - 2 m x 3 m.
Deciduous beating samples or tall conifers. Use 3-m pole to sample one side of each of three trees.

12 Beating - 1 m x 1 m.
Conifer beating samples. Use 1-m pole to sample two sides of each of three trees.

13 Other.

14 Not used presently.

15 Cone counts.
Examine 25 cones from each of 3 trees. Record number affected over total and estimate incidence.

Counts, remarks:	Use as appropriate.
Percent - ocular estimate: (Col. 55-56)	Whenever feasible record as percent affected, e.g. 10, 25, etc.
Percent - percent calculated or sum: (Col. 57-58)	Record as a percent number or sum as dictated by the method.

SOIL DESCRIPTION, SAMPLING, AND ANALYSIS

I.K. Morrison

ARNEWS Form 11A

Introduction

At the outset, a detailed description is made of the soil associated with each ARNEWS plot, and soils are sampled and analyzed at that time and at 5-yr intervals thereafter. Ideally, all ARNEWS plots in a given region should be sampled in the same year for both soils and foliage. Alternatively, to avoid peaks in workload every 5-yr, soils sampling may be staggered with about 20% of the ARNEWS plot; however, foliage and soils should be sampled in the same year.

The following protocol calls for **two** levels of investigation: (1) at the outset, soils will be formally classified into the Canadian System of Soil Classification to the Subgroup level, and sampled as per the Baseline Soil Description and Sampling protocol (which follows); and (2) the same year, and at 5-yr intervals thereafter, a soil monitoring program will be instituted as per the Soil Monitoring protocol (to follow).

As with foliage samples, the principal comparison will be between the same soil over time. Again, as with foliage samples, it is proposed to analyze all samples at the outset, then to store and analyze either all or a subset when future samples become available. The same arguments of minimization of methodological drift, likelihood of new technologies, instrumentation, etc., as with foliage samples apply. Analyses will be done at regional laboratories or as arranged. Samples will be stored at regional laboratories. Results of analyses will be collated as described.

Please adhere to the following protocol.

Baseline Soil Description and Sampling Protocol

FIDS and/or CFS–LRTAP may be required to indicate actual plot locations on the ground, etc.

1. Immediately outside each ARNEWS plot, a **soil pit**, about 1 m x 1 m, sited to be **representative** of the plot at large (generally avoiding obvious hummocks and depressions), to be excavated to the C-horizon. The main pit is considered an off-plot subplot, with location recorded according to rules in section dealing with subplots.
2. In excavating the soil pit, pit content should be piled carefully (preferably on a sheet) on **one** side of the pit only to avoid contamination of the surrounding area.
3. At the time of initial sampling, pedon associated with the soil pit to be **described** as follows:
   - Horizon designation (Canadian terminology)
   - Depth (centimetres from H/A interface)
   - Color (Munsell notation, color name [moist/dry])
   - Texture (field approximation followed by lab. analysis)
   - Mottles (matrix/mottle color, mottle abundance, color, contrast with matrix)
   - Structure (grade/distinctness, class/size, type)
   - Consistence (resistance to deformation, degree of cohesion/adhesion)
   - Roots (abundance, size, orientation, distribution, depth of penetration)
   - Pores (abundance, size, orientation, distribution, continuity, morphology, type)
   - Clay films (frequency, thickness, location, color)
   - Horizon boundaries (lower boundary distinctness, form)
   - Other features.
4. Assign to the appropriate **Subgroup** of the **Canadian System of Soil Classification** (Canada Soil Survey Committee, Subcommittee on Soil Classification 1978) and, in surveyed areas, to the appropriate map unit.
5. Estimate (from pit content) percent (vol/vol) coarse fragment content (shape and kind, size and name).

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SOIL MONITORING — ANALYSE DU SOL

ACID RAIN - NATIONAL EARLY WARNING SYSTEM — DISPOSITIF NATIONAL D'ALERTE RAPIDE DES PLUIES ACIDES

ARNEWS DNARPA 11 A

Assessment Type / Type d'évaluation: 1 1 (1 2)

Plot No. / Nº de la parcelle: (3 4 5)

Collection Date / Date du prélèvement: (20 21 22 23 24 25)

Subplot No. / Nº de la sous-parcelle: (26 27)

Location / Localisation

Sampled by / Prélèvement effectué par

Station	Horizon	Sample Taken (√) Échantillon prélevé	Comments / Remarques
1	Organic / Organique		
	A		
	B		
2	Organic / Organique		
	A		
	B		
3	Organic / Organique		
	A		
	B		
4	Organic / Organique		
	A		
	B		
5	Organic / Organique		
	A		
	B		

Canada

AGR 3767 (88/04)

6. Before collecting soil samples, refilling and marking pit, most illustrative face may be **photographed** in color with scale.
7. For both forest floor and mineral horizons, avoid in each instance contamination with materials from above and beneath, and composite a single sample of materials from all faces of the pit for **each** horizon (L,F, H,A,B,C, etc.). To avoid contamination it may be preferable to collect forest floor (L,F,H) samples before pit excavation from approximately within (proposed) pit perimeter.
8. Collect sufficient volume of field sample in each instance to yield, when sieved of coarse fragments (>2 mm), about 500 cm^3 of **fine-earth** (<2 mm).
9. Field collections may be made into plastic bags or other suitable containers, ensuring that each sample is permanently and legibly **identified** with the following information:

   ARNEWS plot number
   baseline sample
   soil horizon
   collection date
10. In addition, take volumetric samples for bulk density determination of each horizon.
11. Following sampling, refill pits and mark locations permanently using numbered aluminum stakes.

Soil Monitoring Protocol

NOTE: The following procedure and the samples derived therefrom are the responsibility of CFS-LRTAP personnel. Because the samplings depend on the identification of soil horizons, the initial sampling should wait until the horizons have been described. To this extent, at least, the Soil Monitoring Program should be coordinated with the Baseline Survey.

1. Immediately outside each ARNEWS plot, site **five** sampling stations, each representative of the plot at large (generally avoiding obvious hummocks and depressions). Mark permanently with numbered aluminum stakes.
2. Randomly, within about a 5-m radius of each stake, use a **trowel, soil auger**, or other suitable sampling device to obtain samples **composited of at least five subsamples** of the most appropriate or abundant organic, A and B horizons. (NOTE: Avoid contamination of samples with materials, particularly from above. Also, avoid excessive disturbance of the area generally, so as not to invalidate future analyses).
3. Collect sufficient volume of field sample in each instance to yield, when sieved of coarse fragments (> 2 mm), about **500 g** of **fine earth** (< 2 mm).
4. Field collections may be made into plastic bags or other suitable containers, ensuring that each sample is permanently and legibly identified with the following information:

   ARNEWS plot number
   monitoring sample
   station number
   soil horizon
   collection date

Sample Preparation Procedure

NOTE: The following procedure pertains to samples collected under either (1) the Baseline Sampling or (2) the Soil Monitoring Sampling protocols.

1. Following removal to the laboratory, sufficient (about 50 cm^3) subsamples of field-fresh material are set aside for pH and other determinations (to follow).
2. The remaining sample is allowed to air-dry, then sieved through a 2 mm sieve, the <2 mm (fine-earth) fraction being retained, the remainder discarded. For L,F, and H horizons, grind samples in a laboratory cutting mill if the mineral content is sufficiently low (if the mineral content is appreciable, however, the knife blades could be damaged).
3. The samples may be stored in same or other containers, labelled as listed previously.

Soil Analysis Procedures

NOTE: The following procedure pertains to samples collected under either (1) the Baseline Sampling or (2) the Soil Monitoring Sampling protocols.

1. Samples derived from the Baseline Sampling will be analyzed. Samples derived from the Soil Monitoring Sampling will be analyzed at regional laboratories or as arranged.
2. Standards, duplicates, and reagent blanks including extractants should be run with every batch or with every 40 samples, whichever is less.
3. Quality assurance of analytical results will be provided by full and continued participation in the RMCC Quality Assurance Terrestrial Laboratory Intercomparison Program.
4. For forest floor (L,F,H horizon) samples determine:
   - pH in H_2O (field-fresh sample).
   - pH in 0.01 M $CaCl_2$ (field-fresh sample).
   - Total N, (semimicro Kjeldahl procedure or equivalent).
   - Total P,K,Ca,Mg,S,Fe,Mn,B,Zn,Cu,Na,Al (as per plant samples).
   - Cation exchange capacity (1.0 M NH_4Cl, unbuffered, extractant).
   - Exchangeable K,Ca,Mg,Fe,Mn,Zn,Cu,Na,Al (1.0 M NH_4Cl, unbuffered, extractant).
   - Percent base saturation (by summation).
   - Extractable $SO_4 =$ (0.1 M NH_4Cl) (field-fresh sample) (optional).
   - Organic matter (loss-on-ignition).
   - Organic matter (Walkley-Black wet oxidizable) (optional).
5. For mineral (A,B,C horizon) samples determine:
   - pH in H_2O (field-fresh sample).
   - pH in 0.01 M $CaCl_2$ (field-fresh sample).
   - Extractable P (acid soils: Bray & Kurtz No. 1 extractant; calcareous soils: 0.5 M $NaHCO_3$ extractant).
   - Cation exchange capacity (1.0 M NH_4Cl, unbuffered, extractant).
   - Exchangeable K,Ca,Mg,S,Fe,Mn,Zn,Cu,Na,Al (1.0 M NH_4Cl, unbuffered, extractant).
   - Percent base saturation (by summation).
   - Organic matter (loss-on-ignition).
   - Organic matter (Walkley-Black wet oxidizable) (optional).
   - Total S.
   - Pyrophosphate - extractable Al,Fe,Mn.
6. Analytical results to be reported in following units:

Total N	(g/kg)
Total, extractable P	(mg/kg)
Cation exchange capacity	(cmol (+)/kg)
Exchangeable cations	(cmol (+)/kg)
Exchangeable anions	(cmol (-)/kg)
Total S	(g/kg)
Pyrophosphate-extractable Al,Fe,Mn	(g/kg)

7. Results of analyses to be reported to responsible LRTAP or other designated staff at each establishment who in turn forward the same to the ARNEWS Plant/Soils Coordinator. Local FIDS units should also be provided with copy of results for plot files.
8. Remaining sample to be stored at the regional establishment for future analysis, unless otherwise arranged.

FOLIAGE SAMPLING AND ANALYSIS

I.K. Morrison

ARNEWS Form 11B

Introduction

Foliage analysis is one of the ARNEWS procedures repeated at 5-yr intervals (unless special circumstances dictate otherwise). Ideally, all ARNEWS plots in a given region should be sampled in the same year for both foliage and soils and at 5-yr intervals thereafter. Alternatively, to avoid peaks in workload every 5-yr, foliage sampling may be staggered, sampling about 20% of the ARNEWS plots in a region annually.

Foliage sampling is the responsibility of FIDS staff whereas sample preparation and analysis are the responsibility of LRTAP or other designated staff at each regional establishment.

Foliage and soils sampling and analysis is often proposed as a method of environmental monitoring. The intent of the ARNEWS plant/soils analysis program is to (1) establish a baseline; (2) measure departures, if any, over time from this baseline; and (3) ascertain, if possible, causes of these departures. Obscuring any trends, however, may be natural variability related to species and site, tree-to-tree and within-tree variability, and season-to-season and within-season variability. In addition, errors may be introduced in the sample preparation and analytical steps. The following procedures are proposed to minimize variability and errors.

In brief, the procedure calls for sampling 10 trees of each of the two principal tree species on each ARNEWS plot, by collecting current leaves from the mid- to upper parts of the live crowns of well-formed dominant or codominant trees, and by returning the samples to a laboratory for oven-drying and analysis.

The principal comparison will be between samples from individual trees over time, with each species replicated 10 times per plot and changes in element concentration or similar measures being the basis for comparison (further comparisons could include species-to-species, plot-to-plot, etc.). An initial analysis will be conducted at the outset. Either all or a subset of the original samples will be analyzed with samples from future samplings. The chief arguments in favor of re-analysis are (1) reduction of methodological error involving machine drift, etc., (2) the likelihood that new methods and instrumentation will render later analyses more useful. Analyses will be done at regional laboratories or at a central location as arranged. Results of analyses will be collated as described.

Please adhere to the following protocol.

Field Procedure

1. Take samples from trees located immediately **outside** each ARNEWS plot. Ensure that stand and site conditions where the sample trees are located are the same as inside the plot.
2. Take samples from no more than **two** species per plot, normally the two most abundant (in BA) main-stand species, or in equal mixedwoods, the most abundant coniferous and the most abundant hardwood species.
3. Take samples from 10 well-formed trees of either the **dominant** or **codominant** crown classes for **each** of the two species.
4. Take samples from the **same** trees at both the initial and subsequent samplings. To permit resampling the same trees, sample trees are to be **numbered** (using a numbering sequence distinct from the Plot Tree numbers) with numbered metal tags affixed to the trees 2 cm below the breast-height position with aluminum nails, the nail heads protruding about 2 cm (to allow for future growth). For each sample tree at each sampling, record number, DBH, total height, and general condition (if a sample tree dies or is removed between samplings, replace with a tree of the same species and similar dimensions, and a new number).
5. At each sampling, collect foliage samples from each of the 10 individually numbered trees per species per plot following instructions 6 through 13.

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FOLIAGE SAMPLING
ACID RAIN - NATIONAL EARLY WARNING SYSTEM

ÉCHANTILLONNAGE DU FEUILLAGE
DISPOSITIF NATIONAL D'ALERTE RAPIDE DES PLUIES ACIDES

ARNEWS DNARPA 11 B

Assessment Type / Type d'évaluation (1 2): 1 1

Plot No. / Nº de la parcelle (3 4 5):

Collection Date / Date du prélèvement (20 21 22 23 24 25):

Subplot No. / Nº de la sous-parcelle (26 27):

Location / Localisation

Sampled by / Prélèvement effectué par

First Species / Première essence

Tree Number / Nº de l'arbre	DBH / DHP	Total Height / Hauteur totale	Condition / État	Sample Taken (√) / Échantillon prélevé

Second Species / Deuxième essence

Tree Number / Nº de l'arbre	DBH / DHP	Total Height / Hauteur totale	Condition / État	Sample Taken (√) / Échantillon prélevé

Canada

AGR 3768 (86/04)

6. For both coniferous and hardwood species, samples are to be of **whole, well-formed, current-year leaves**, preferably from several branchlets representing various sides of the **mid- to upper part of the live crown** of each sample tree (if impossible to reach mid- to upper part of live crown, sample position should be recorded).
7. For coniferous species (other than larches), samplings are to be made during the **dormant** season, preferably from late September through early March (depending upon locality), when element concentrations are most stable.
8. For hardwood species, and for larches, samplings are to be made **late** in the growing season, but at least 2 wk before the onset of autumn coloration (this suggests late-July to late-August in most instances).
9. Actual method of sample procurement (e.g. tree climbing, pole pruners, shooting, etc.) will vary with local conditions, especially with factors such as tree height.
10. Take enough at each sampling to determine leaf (fascicle) weights (see Sample Preparation Procedure, 3.) and, when finally oven-dried and ground, to yield approximately 25–50 g of sample material.
11. For coniferous species, use secateurs to separate current-year leaves and twigs from older leaves and twigs; retain only current-year leaves and twigs, collecting enough to approximately half fill (when tamped down) a 10-lb (9 x 16 x 35 cm) Kraft paper bag. For hardwood species, collect enough fresh, whole (blade and petiole) leaves to give the same volume. Clip foliage so that it falls directly into bags with a minimum of handling. Staple shut.
12. Ensure that the bags containing the samples are labelled with the following information:
    ARNEWS plot number
    species
    sample tree number
    sample position
    collection date
    additional notes (e.g. abnormal coloration)
13. If possible, return samples for **chemical analysis** to a laboratory within 24 h for oven-drying. If impossible, allow samples to thoroughly air-dry. Normally, this can be achieved by opening the bags, placing them in a dry, well-ventilated location, and turning the sample over periodically.

Sample Preparation Procedure

1. Leaving the samples (for chemical analysis) in their original bags, oven-dry at 70 C till constant weight, a procedure normally taking about 24 h in most forced-draught, laboratory ovens.
2. Separate foliage from twigs or other material (for hardwood leaves, ensure petioles attached).
3. For conifers only, determine mean fascicle weight as follows: count out 100 randomly selected, undamaged, oven-dried fascicles from the sample on hand. Re-dry if necessary. Weigh to nearest 0.0001 g on a semimicro balance. Divide total weight by 100. NOTE: Expected numbers of needles per fascicle for the main species are as follows:

eastern, western white pines	5
pitch, ponderosa pines	3
red, jack, lodgepole pines	2
spruces	1
hemlocks	1
firs	1
Douglas-firs	1
cedars, junipers, larches, etc.	disregard

4. Grind oven-dry sample to pass a 1-mm (alternatively, 20-mesh) screen using a laboratory cutting mill; retain 25–30 grams of final sample and store away from light in an air-tight, about 100-ml glass or other suitable container. Ensure that the sample number and other identifying information is recorded legibly and permanently on the **side** of the container (not the lid).

Analytical Procedure

NOTE: The initial analysis is mainly for characterization. The bulk of the sample is to be stored for future comparison.

1. The initial analysis will be carried out in regional laboratories or as arranged. Subsequent analyses to be arranged. For the initial analysis, there will be 20 samples per plot, one for each of 10 trees of 2 species. For subsequent samplings, samples from the original sampling will be analyzed as well.
2. Re-dry samples at 70 C immediately before analysis.
3. Standards, duplicates, and reagent blanks should be run with every batch or with every 40 samples, whichever is less.
4. Quality assurance of analytical results will be provided by full and continued participation in the RMCC Quality Assurance Inter-Laboratory Comparability Program.
5. For the initial analysis, samples are to be analyzed for:

Total N	(mg/g)
Total P	(mg/g)
Total K	(mg/g)
Total Ca	(mg/g)
Total Mg	(mg/g)
Total S	(mg/g)
Total Fe	(µg/g)
Total Mn	(µg/g)
Total Zn	(µg/g)
Total Cu	(µg/g)
Total Na	(µg/g)
Total Al	(µg/g)

6. Results of analyses to be reported to responsible LRTAP or other designated staff at each establishment who in turn forwards the same to the ARNEWS Plant/Soils Coordinator. Local FIDS unit should also be provided with copy of results for plot files.
7. Remaining sample to be suitably stored at the regional establishment for future analysis, unless otherwise arranged.

INCREMENT CORES AND GROWTH RING ANALYSIS

ARNEWS Form 12

A 5-yr procedure involving the collection of increment cores from numbered, off-plot trees. INCREMENT CORES are to be taken from 10 codominant trees for each tree species represented on the plot, if possible. When a tree species constitutes less than 10% of the plot it may not be practical to locate the required number of outside trees in the vicinity of the plot.

A single increment core is to be collected from each tree sampled and should be taken from the north-facing side of the tree at breast height. Cores are to be cemented in corrugated cardboard holders using glue (such as Lepage's Household Cement), labelled as shown (see 12/3), and stored for drying and ultimate ring analysis. Separate containers should be used for each species to avoid confusion.

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GROWTH RING ANALYSIS
ACID RAIN - NATIONAL EARLY WARNING SYSTEM

ANALYSE DES NOYAUX DE CROISSANCE
DISPOSITIF NATIONAL D'ALERTE RAPIDE DES PLUIES ACIDES

ARNEWS DNARPA 12

Assessment Type / Type d'évaluation [1 2] (1 2)

Plot No. / Nº de la parcelle [ ] [ ] [ ] (3 4 5)

Collection Date / Date du prélèvement [ ] [ ] [ ] [ ] [ ] [ ] (20 21 22 23 24 25)

Subplot No. / Nº de la sous-parcelle [ ] [ ] (26 27)

Tree Species / Essence [ ] [ ] [ ] (33 34 35)

Tree No. / Nº de l'arbre [ ] [ ] [ ] [ ] (36 37 38 39)

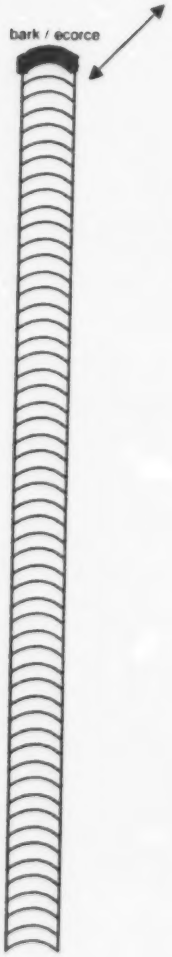
Plot Location / Localisation de la parcelle

Measured by / Mesure par

Date Measured/Date des mesures

Year of Most Recent Ring / Année du dernier anneau de croissance [ ] [ ] [ ] [ ] (40 41 42 43) = 00 below / plus bas

bark / écorce



Calendar Year / Année civile	Year design / Année designée (44 45)	Width of Ring / Épaisseur de l'anneau (mm) (46 47 48)	
	0 0		
	0 1		
	0 2		
	0 3		
	0 4		
	0 5		
	0 6		
	0 7		
	0 8		
	0 9		
	1 0		
	1 1		
	1 2		
	1 3		
	1 4		
	1 5		
	1 6		
	1 7		
	1 8		
	1 9		
	2 0		
	2 1		
	2 2		
	2 3		
	2 4		

Calendar Year / Année civile	Year design / Année designée (44 45)	Width of Ring / Épaisseur de l'anneau (mm) (46 47 48)	
	2 5		
	2 6		
	2 7		
	2 8		
	2 9		
	3 0		
	3 1		
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	3 4		
	3 5		
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	3 7		
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	3 9		
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(continue on other form if necessary / au besoin, poursuivre sur un autre formulaire)

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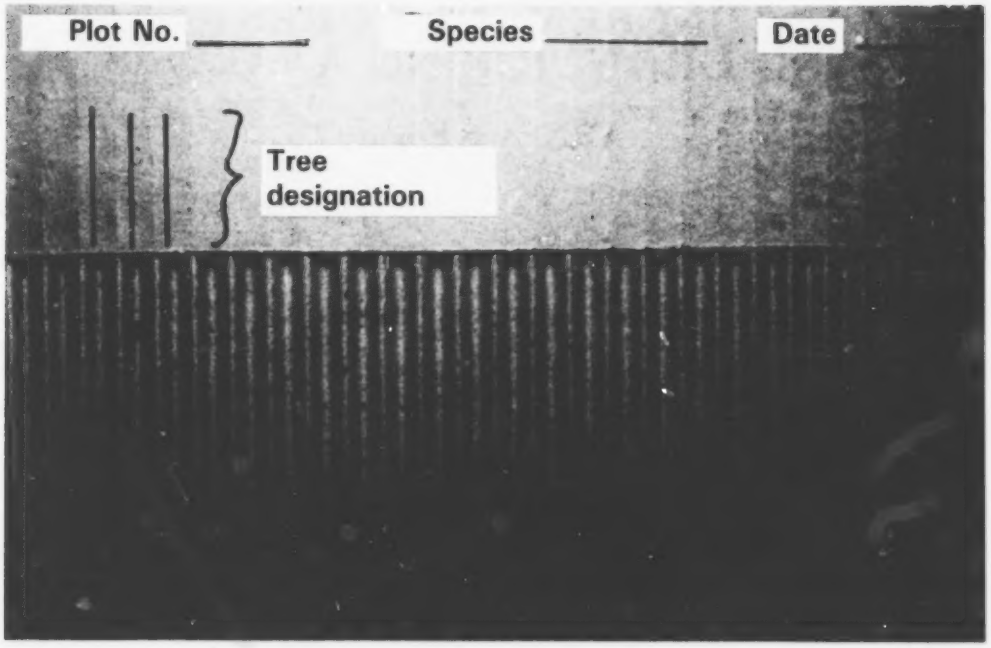

The trees used in obtaining the increment cores may be considered as subplots or may be listed on ARNEWS form 13. They should be marked for easy relocation because other (annual) assessments are carried out on them.

INCREMENT CORES AND GROWTH RING ANALYSIS

ARNEWS Form 12

Assessment type: (Col. 1-2)	Same as ARNEWS form number expressed as two-digit number. 12 signifies form 12 for Increment Core Analysis.
Plot number: (Col. 3-5)	Record three-digit plot designation, i.e. region-number, e.g. 305.
Collection date: (Col. 20-25)	Enter as two-digit numbers for year-month-day (in that order), e.g. September 7, 1984 = 840907.
Subplot number: (Col. 26-27)	Enter as two-digit number, e.g. subplot 3 = 03, subplot 15 = 15.
Tree species: (Col. 33-35)	Use standard FIDS species designations, e.g. balsam fir = 003.
Tree number: (Col. 36-39)	Record as four-digit number, e.g. tree 57 = 0057.
Location:	Name the plot by location to avoid coding error and to aid in hand sorting.
Measured by:	Name of the individual who actually measures the annual rings.
Year of most recent ring: (Col. 40-43)	Enter the year as four-digit number, e.g. 1984 = 1984. This date is the same as the year of collecting the increment core if it was done in the fall or early winter, i.e. after the growing season but before the end of the calendar year or 1 yr earlier if the increment core was collected in early spring (i.e. before the next growing season).

The main body of the form will be used to record the width of individual annual rings if recording is manual or it is left blank when automated, computerized equipment is used. Although the automated annual ring measuring system will likely render manual recording of ring widths obsolete, the headings should be filled out as a record of the work completed. (Appropriate notes regarding computer storage may be useful.)

OFF-PLOT TREE DATA

ARNEWS Form 13

This form is not connected to any specific assessment, rather it is for "housekeeping" convenience to record the various off-plot trees used for a variety of purposes. It is also a viable alternative to recording off-plot trees as subplots. CFS regions may choose how to handle off-plot trees.

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OFF - PLOT TREE DATA

ACID RAIN - NATIONAL EARLY WARNING SYSTEM

DONNÉES D'ARBRES À L'EXTÉRIEUR DES PARCELLES

DISPOSITIF NATIONAL D'ALERTE RAPIDE DES PLUIES ACIDES

ARNEWS DNARPA 13

Assessment Type / Type d'évaluation: 1 3 (1 2)

Plot No. / Nº de la parcelle: (3 4 5)

Assessment Date / Date de l'évaluation: (20 21 22 23 24 25)

Location / Localisation

Mapped by / Mise en plan par

Page of / de

Tree Number / Numero de l'arbre				Tree Species / Essence			DBH / DHP (cm)				Age from ARNEWS 12 (AGR 3359) / Âge d'après DNARPA 12			Comments / Remarques
33	34	35	36	37	38	39	40	41	42	43	44	45	46	
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AGR 3360 (87/04)

OFF-PLOT TREE DATA

ARNEWS Form 13

Assessment type: (Col. 1-2)	Same as ARNEWS form number expressed as two-digit number. 13 signifies Off-Plot Tree Data.
Plot number: (Col. 3-5)	Record as three-digit plot designation, i.e. region-number, e.g. 305.
Assessment date: (Col. 20-25)	Enter as two-digit numbers for year-month-day (in that order), e.g. September 7, 1984 = 840907.
Location:	Name the plot by location to avoid coding error and to aid in hand sorting.
Mapped by:	The name(s) of individual(s) involved.
Page_of_:	Complete after last tree is entered to assist in form handling.
Tree number: (Col. 33-36)	Record as four-digit number, e.g. tree 57 = 0057.
Tree species: (Col. 37-39)	Use standard FIDS designations, e.g. balsam fir = 003.
DBH: (Col. 40-43)	Record to the nearest 0.1 cm as a four-digit number, e.g. 12.5 cm = 0125, 125.0 cm = 1250.
Age: (Col. 44-46)	Obtain from increment core (most likely from ARNEWS form 12) and record as three-digit number, e.g. 57 yr old = 057.
Comments:	Use as required.